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THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE INSTITUTION OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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NOTES AND COMMENTS.

The Co-relation of Furnace Costs.

From time to time there appears in technical literature a comparison of the running costs of two or more vastly divergent processes, but in the ordinary way such results are of little practical interest. An American concern has recently compared the cost of the metal in the ladle in two of their works, one of which operates a 20-ton oil-fired acid open-hearth and the other a three-ton over-loaded electric furnace, worked on a semi-continuous process, by leaving part of the liquid finished steel in the furnace as raw material for the next charge. The result was, at a normal rate of exchange, an advantage of £1 10s. per ton was shown in favour of the larger unit. But, is it fair to compare furnaces of such varying capacities? We are convinced that if a comparison were made between a 5-ton open-hearth furnace, working under exactly similar conditions to the 20-ton furnace referred to, the difference would be roughly the same. A further consideration—and one which is difficult to record in monetary terms—is the question of the quality of the product.

Some unpublished figures go to show that under French conditions a 3-ton electric furnace was producing steel in the ladle cheaper than a 15-ton basic open-hearth furnace by £2 5s. 2d., at normal rate of exchange. But here again the conditions were extraordinarily divergent, as the electric furnace was modern in every way and produced high-class steel, whereas the basic furnaces were old-fashioned and engaged in a cheap production. In comparing the costs of any two processes there are usually a number of costs which are stationarily relative, such as the alloy, labour and slag costs, and the variable factors are oil, gas and electricity. It should not be a difficult matter when preparing comparative costs to state the relative costs on a percentage basis and the non-relative costs on a scale basis on the cost price of the raw material. It would then immediately be seen, should the price of a raw material peculiar to one certain process reach a high figure, whilst that for a competitive process remain stationary or decrease, whether it is advisable to abandon temporarily the working of the first process. Obviously the question of quality of product and the reliability of the proposed processes must be considered. This factor has been recognised by the oil, and some electricity companies who guarantee the steadiness of their prices for a considerable period. Industry, too, has recognised that certain processes, economic during the war, are no longer so, and every plant subject to competition with another process should be supplied with a graph or table, which would show the point where the method is no longer economic in relation to competitive processes and also when the latter should be carefully studied by the costs department. With the possible exception of oil, this was not worth while before the war, but nowadays economic conditions change so rapidly that too much consideration cannot be given to the question. In order that the costs department may not be led astray, they should be supplied by the manufacturing staff with some notes as to the technical possibility or impossibility of alternative processes.

Institution of British Foundrymen—Conference at Blackpool.

Railway Arrangements.—Members who desire to travel to Blackpool by the Lancashire and Yorkshire Railway on the Friday or Saturday before the conference will require to make application to their "home" station a few days beforehand for special tickets authorising them to travel by specified trains. There is no restriction on any other days. Members travelling by the L. & N.W. Railway viâ Crewe or Wigan, or from stations north of Preston on the Friday or Saturday, September 16-17, will be booked through on application.

Return Journey.—Members returning by L. & Y. or L. & N.W. trains from Blackpool or stations to Lytham on Saturday, September 17, or Monday, September 19, will require special tickets, which will be issued in advance, authorising them to travel by a specified train.

Friday, September 16.—Special tramcars conveying the party to Fleetwood will leave Talbot Road Station at 9.15 a.m.

Another Foundry Competition.

Mr. J. Ellis, a Past President of the Institution of British Foundrymen, has been offering a prize for the best essay on foundry work. He has forwarded for our inspection the two winning efforts. The winners—J. W. Roberts, aged 15, and J. P. Ellis, aged 17—are to be congratulated on the excellence of their work, and we hope that Mr. Ellis' excellent example will be followed by other progressive foundrymen.

XUM

Some Failures of Chilled Cast-Iron Wheels.*

By H. J. Force.

The cast-iron wheel has a marvellous history. To-day the commerce of the nation depends upon it. Approximately 26,000,000 chilled-iron wheels are now in use in the United States and Canada, serving under freight cars, passenger coaches, refrigerator cars, engine tenders, city street cars, interurban cars and electric locomotives. Eighty to ninety per cent. of all the equipment in the United States and Canada is equipped with cast-iron wheels. The annual production in the United States is approximately 3,000,000 wheels, some of which are exported to France, Russia, Italy and other foreign countries. A large proportion of the total production is required for repairs.

TABLE 1.—*Wheels Worn Out on Service.*

Mark.	Cast.	Graphitic carbon.	Combined carbon.	Phosphorus.	Sulphur.	Manganese.	Silicon.
A	9–20–15	2.32	0.99	0.360	0.154	0.49	0.70
B	6– 2–16	2.77	0.75	0.308	0.136	0.66	0.73
C	7– 2–13	2.18	0.98	0.304	0.155	0.55	0.65
D	8–24–12	2.15	0.93	0.260	0.122	0.43	0.59

It may be asked why chilled-iron wheels have proved so satisfactory, when other parts of car, track and structure have been superseded by other and more expensive materials. This is due to the character of the metal, for no other material has been made able to make any serious inroad on the chilled-iron wheel for the past seventy years.

It is the object of this paper to point out such recommendations and changes as are thought to be necessary in the chilled-iron wheel. It is well known that during the past few years railroad cars have been loaded to greater capacity; heavier equipment has been placed on many lines; many roads are using rails much heavier than a few years ago; roadways are rock ballasted, and are very largely equipped with tie plates. This rigid track construction has placed a greater duty upon the chilled-iron wheel, a condition which the manufacturers possibly may not have realised, for little effort has been made to improve the quality of the wheels to meet these conditions.

The cast-iron wheel is about the only part of railroad equipment which is not purchased to a chemical specification; yet it is the most important part of such equipment. The failure or breakage of one wheel in a train almost invariably results in derailment. Such chemical specifications as have been recommended are not generally acceptable both to the manufacturer and the consumer. It is generally conceded that unless an improvement is made in the quality of cast-iron wheels the railroad lines will be forced to give careful consideration to the use of steel wheels, with the hope that fewer failures will result in service. From a study of the service condition of cast-iron wheels we are of the opinion that this wheel can be greatly improved, and that it will be found to be satisfactory under nearly all equipment. It has been claimed that the ordinary wheel on certain lines is satisfactory. This may be true where such lines do not have any lengthy and heavy grades, but where these grades do exist failures from cast-iron wheels are constantly resulting; and as all class of equipment is handled over these lines, it is therefore necessary that the wheels on all lines be made of the best possible composition.

TABLE 2.—*Wheels Failed in Service.*

Mark.	Cast.	Graphitic carbon.	Combined carbon.	Phosphorus.	Sulphur.	Manganese.	Silicon.
1	8–27–17	2.24	1.01	0.420	0.176	0.57	0.70
2	—	2.13	1.23	0.430	0.191	0.41	0.82
3	—	2.46	0.89	0.440	0.200	0.65	1.06
4	4–15–18	1.87	1.50	0.384	0.182	0.39	0.75
5	5–28–13	2.19	1.14	0.388	0.199	0.52	0.75
6	3–28–18	2.10	1.24	0.386	0.146	0.36	0.76
7	6–28–20	1.91	1.31	0.354	0.193	0.52	0.80
8	8–21–19	1.99	1.21	0.384	0.261	0.67	0.88
9	3–14–18	2.24	0.95	0.364	0.171	0.50	0.84
10	3– 9–20	2.15	1.19	0.428	0.185	0.52	0.69
11	10–13–17	2.16	1.03	0.408	0.138	0.38	0.70
12	9– 3–19	2.24	1.08	0.370	0.197	0.60	0.76
13	12–30–18	2.34	0.98	0.420	0.175	0.79	0.73
14	—	2.14	0.98	0.420	0.219	0.72	0.93
15	2–17–15	2.20	1.12	0.400	0.190	0.43	0.68

During the year 1920 forty-two failures occurred from broken wheels on the lines of the Lackawanna Railroad, and, with very few exceptions, these were on foreign cars. For 1921 twenty failures have occurred which caused derailment.

Four wheels were selected from a number of wheels which had been worn out and marked A, B, C, and D. Table 1 shows the date each wheel was cast, and gives the composition. It will be noted that in most cases these wheels meet the requirements of the specifications recommended later, although no effort apparently was made to make the wheels to any specification. The table shows the fact that the composition as to phosphorus and sulphur, and especially silicon, is fairly satisfactory. It should also be pointed out that the wheel with the lowest sulphur and lowest phosphorus apparently gave the best service. The higher silicon wheels in all cases showed more wear than lower silicon wheels. On the other hand it is believed that the combined carbon content, which in one case is as high as 0.99 per cent., is outside the limit for a cast-iron wheel which would give the best service.

Table 2 shows a list of wheels which failed in service, and in each case caused a serious derailment. Note here the high combined carbon, high phosphorus and uniformly high sulphur, in some cases low manganese, and in many cases high silicon. Wheels of this composition should not, under any circumstance, be placed in service. Some of these wheels gave very little service, and we feel safe in saying that the wheels described in this table were shipped without the knowledge of the manufacturers as to their chemical composition.

TABLE 3.—*Chemical Analyses of Wheels from Three Foundries.*

Foundry.	Graphitic carbon.	Com'bd. carbon.	Phosphorus.	Sulphur.	Manganese.	Silicon.
B	2.58	0.79	0.320	0.157	0.57	0.70
	2.70	0.79	0.350	0.143	0.53	0.67
	2.47	0.83	0.320	0.143	0.61	0.69
	2.56	0.63	0.340	0.157	0.59	0.73
	2.68	0.77	0.370	0.164	0.54	0.77
	2.78	0.57	0.350	0.144	0.52	0.72
	2.83	0.51	0.340	0.142	0.50	0.77
	2.86	0.51	0.360	0.158	0.48	0.74
A	2.63	0.77	0.290	0.158	0.54	0.63
	2.55	0.61	0.350	0.153	0.68	0.64
	2.53	0.73	0.300	0.142	0.57	0.74
	2.94	0.61	0.290	0.130	0.59	0.76
	2.84	0.53	0.270	0.141	0.56	0.69
	2.94	0.48	0.300	0.148	0.54	0.75
	2.69	0.62	0.296	0.144	0.52	0.76
N	2.65	0.85	0.320	0.148	0.52	0.65
	2.57	0.90	0.330	0.132	0.49	0.71
	2.41	0.76	0.280	0.141	0.60	0.63
	2.36	0.79	0.330	0.132	0.59	0.68
	2.49	0.80	0.320	0.134	0.61	0.66
	2.56	0.75	0.320	0.130	0.55	0.64
	2.51	0.70	0.330	0.134	0.58	0.72
	2.56	0.73	0.292	0.142	0.52	0.70
	2.60	0.75	0.292	0.125	0.58	0.75
	2.46	0.81	0.296	0.137	0.60	0.71
	2.50	0.79	0.286	0.140	0.52	0.72
	2.55	0.77	0.300	0.126	0.57	0.74
	2.75	0.51	0.304	0.135	0.53	0.67

Table 3 shows analyses on a number of wheels made on different dates by three different wheel foundries, the majority being cast in 1920. Under foundry B, which was asked to furnish wheels with not over 0.35 per cent. phosphorus, it will be noted there is considerable high phosphorus. This, we might say, was their first attempt to make wheels to a chemical specification. The same request was made of foundry A, and in this case all wheels conform to the specification as to phosphorus. In foundry N effort was then made to have the wheels contain not over 0.32 per cent. phosphorus. It will be noted that in every case the wheels conform very closely to the specification, and it is felt that no undue hardship will be imposed upon the wheel makers to have the phosphorus not over

* From a Paper presented at the Asbury Park meeting of the American Society for Testing Materials. The author is chemist and engineer of tests, Lackawanna Railroad Co., Scranton, Pa.

0.32 per cent., and that a better and safer wheel will in every case be made.

It is not contended that a chemical requirement will at once eliminate all wheel failures, for it is possible that an occasional wheel will fail in service from inferior composition due possibly to some oversight on the part of a workman in the foundry.

In order to show the necessity for chemical requirements in a specification, we call attention to an analysis of 252 wheels from twenty-eight different foundries that were being removed in the author's works in the ordinary routine of operation. No selection whatever was made; the wheels were taken just as they came into the shop to be removed for the various causes cited below :—

Cause of removal.	No. of wheels.	Average life. Years.	Months.
Brake burns	21	5	1
Cracked plates ..	61	4	5
Seamy rims	31	6	11
Worn flanges	56	7	8
Worn through chill ..	4	7	2
Shelled out	33	6	6
Seamy treads	4	4	0
Slid flats	35	3	4
Chipped rims	7	8	1
Total	252	5	5

The average life of these 252 wheels was five years and five months. The total percentage of cracked plates in this lot is approximately 24 per cent. Taking this as an average, the total number of wheels removed for cracked plates during a period of twelve months on the Lackawanna Railroad would be approximately 8,000.

In our judgment, the cracking of plates is due very largely to inferior chemical composition. Seamy rims and seamy treads are, as a rule, due to foundry practice, and are usually the result of metal being poured at too low a temperature. Immediate improvement in both manufacture and composition of cast-iron wheels is necessary.

It is recommended that the question of drop test and thermal test be carefully investigated. We believe these tests should be made as severe as possible, so that none but good wheels may be shipped.

The Association of Manufacturers of Chilled Car Wheels, representing a large number of manufacturers throughout the United States and Canada, have given assurance that they are anxious to lend all possible assistance in the production of a first-class wheel. We are therefore recommending the following specification, covering all weights of chilled iron wheels :—

Specification "A."

	Per cent.
Total carbon	3.00 to 3.65
Combined carbon	0.45 to 0.85
Manganese	0.50 to 0.75
Phosphorus	Not over 0.32
Sulphur	Not over 0.17
Silicon	0.45 to 0.75

It is felt that the heavier wheels which are now being recommended will tend to reduce failures.

It is recommended that special consideration be given to a wheel which contains a small percentage of nickel and chromium, as indicated in specification B. Wherever wheels of this composition have been used, the results have been highly satisfactory; they should be suitable for the heavier equipment. The increased cost of these wheels will run from 7 to 10 per cent.

Specification "B."

	Per cent.
Total carbon	3.20 to 3.75
Combined carbon	0.40 to 0.80
Manganese	0.45 to 0.65
Phosphorus	Not over 0.15
Sulphur	Not over 0.17
Silicon	0.45 to 0.70
Chromium	0.10 to 0.25
Nickel	0.10 to 0.20

Every wheelmaker understands that while his metal may be of the proper composition, an inferior wheel can be produced due to faulty foundry practice, such as allowing wheels to be cold when pitting, or maintaining pits in improper condition. However, if the foundry practice is correct, and the wheels are of the proper chemical composition, there is every reason to believe that a good, safe, cast-iron wheel can be produced. The drop and thermal tests, together with an examination of the fracture and depth of chill, usually reveal the method of foundry operation.

The majority of the failures of wheels previously cited occurred near the bottom of long, heavy grades, probably due to the elevated temperatures which the wheels attained. In nearly all cases failure occurred by rupture of the plate, and it is important, therefore, that the composition be controlled so that as much strength as possible may be obtained and the wheel enabled to withstand these elevated temperatures.

With the increase in weight of the wheel, the heavier plates and thicker flanges, there is good reason to believe that the cast-iron wheel will serve the railroads of the United States for many years

DISCUSSION

The question of chilled cast-iron wheel and specifications was taken up at the annual meeting of the American Society for Testing Materials, and was introduced by Dr. Richard Moldenke, who presented the report of committee A-3 on cast iron. The principal feature of this report, which is treated more in detail in the account of committee reports, was the recommendations regarding specifications for cast-iron wheels. Proposed tentative specifications for cast-iron wheels, A 46-21 T, were submitted in the usual manner. There had been, however, no little difficulty in settling on the chemical specifications, a matter which has caused trouble before. Dr. Moldenke, in offering the report, submitted suggested chemical specifications which had been arrived at after the last meeting of the committee, based on new information. They included :—

	Per cent.
Combined carbon	0.50 to 0.85
Manganese	0.50 to 0.75
Sulphur	0.18 maximum
Phosphorus	0.30 to 0.40
Silicon	0.45 to 0.75

Dr. Moldenke's report was followed by the reading of a Paper by H. J. Force, chemist and engineer of tests, Delaware, Lackawanna and Western Railroad, Scranton, Pa., entitled "Some Failures of Cast-Iron Wheels." The author prefaced his Paper by saying that in 1913 the total loss by railroads due to accidents of all kinds was about $33,000,000; in 1919 this had grown to $106,000,000. A large part of this—too large a portion—he said, was due to damage to freight caused by derailment accidents with the principal cause ascribed to poor iron car-wheels. "By no means are the car-wheels as a whole satisfactory."

The discussion was opened by G. E. Doke, engineer of materials, New York Central Railroad, Cleveland, who advocated some such specifications as offered by the committee or by Mr. Force. He was sure that proper chemical composition would result in better wheels, and he laid emphasis on the need of a thermal test in such specifications, citing cases of wheels containing 1.02 per cent. combined carbon which failed in 150 sec. and wheels of 1.26 per cent. combined carbon, which failed in 100 sec. in such a test.

George W. Lyndon, president Association of Manufacturers of Chilled Car Wheels, which represents 25 companies having a capacity of 25,000 car wheels per day, expressed the interest of his Association in any proposition to improve wheels, and declared his belief in chemical specifications. He said he could not recommend those of Mr. Force, because of the difficulties which would be encountered by Pacific Coast and Southern car-wheel makers in getting material to meet these. He mentioned the fact that the Association had an electric furnace in its research laboratory for studying this and other problems, and assured the Society if it adopted chemical specifications they would be submitted to the members of the Association and carefully passed on.

F. K. Vial, consulting engineer of the Car Wheel Association and of the Griffin Car Wheel Company, said that he felt the combined carbon proposition and the depth of chill were so important that they should be included in any specifications; that the vital part was a proper balance

in the specifications with the combined carbon below 0.85 to 0.90 per cent., and with the manganese three times the sulphur content at least—conditions not always found to exist.

Electric Refining for Car Wheels.

Dr. Moldenke dealt on the necessity for increased quality in car wheels, and referred to the recommendations of Mr. Force concerning the presence of nickel and chromium in one set of his suggested rules. If such elements are included, Dr. Moldenke felt they should be introduced in the original pig-iron, and not by means of alloys or otherwise. He also called attention to the necessity of watching cupola practice, and asserted that, by the use of the basic electric furnace in conjunction with the cupola, desired results as to composition and refinement could be obtained by direct action. He raised the question as to what Southern makers could do to meet a specification of 0.30 to 0.40 per cent. phosphorus when their pig-iron already runs 0.50 per cent.

Robert Job, vice-president Milton Hersey Company, Limited, Montreal, Canada, testified that in his experience the combined carbon in failed car wheels has exceeded 0.90 per cent., the phosphorus 0.30 and the sulphur 0.15 per cent. He believed proper specifications, such as those of the Lehigh Valley Railroad, should include combined carbon 0.50 to 0.75 per cent., with 0.85 per cent. as a maximum; manganese, 0.50 to 0.70 per cent., with phosphorus at 0.30 per cent. as a maximum; and sulphur with 0.16 per cent. as an upper limit.

C. T. Ripley, of the Santa Fe system, declared that cracked plates were a serious consideration; that 10 years ago chemical specifications were not a governing factor, and that the two main reasons for failed wheels were cracked plates and slag inclusions. He recommended the arch plate wheel, which, in his experience, had cut failures down to one-tenth for cracked plates. He emphasised the need to consider the kind of service to which wheels are subjected in judging their value, because of the rough manner in which trains are often handled. He favoured the proposed specifications, but suggested they include the arch plate wheel.

Dr. G. B. Waterhouse, Lackawanna Steel Company, Buffalo, N.Y., suggested that, from a steelmaker's point of view, the proposed specifications would tie down makers too closely, particularly in limiting the silicon content, but this was answered by others, who said they were making wheels successfully to such specifications.

Gurney Foundry Company, Ltd.*

The Gurney Foundry Company, Ltd., which is well known throughout Canada, was founded in the year 1843. From its earliest inception the business progressed steadily, and in the year 1868, a branch of it was established in Toronto. Later on, this became the Company's principal establishment, and the original plant at Hamilton was relinquished. Some fifteen years ago, the Company built a plant at West Toronto—some five miles from the centre of the city. It possesses another plant also in Toronto—at 500, King Street West—where its chief executive offices are also situated. Further, the Company, last year, added to its plants its present Montreal undertaking conveniently situated at St. Laurent, just a few miles distant from Montreal.

The Gurney Foundry Company, Ltd., has two subsidiary organisations. One of these is the Gurney-Massey Company, of Montreal, which is a distrbuting house for the Company's products east of Brockville, Ont. The other is the Gurney North West Foundry Company, of Winnipeg. The last-mentioned concern is a distributing house for the Company's products in the Western provinces, with the exception of British Columbia. For British Columbia, the Company has a separate distributing house at Vancouver, called the Gurney Foundry Company, as it does not constitute a separate company in itself.

The Company's employees at the present time number about 1,000. As business can scarcely be said to have been at normal, in the lines which the Company manufacture, for several years, the fact that it maintains so large a staff of employees, under present business conditions, is eloquent testimony as to the volume and scope of its manufacturing operations. The Company deservedly enjoys the reputation of being an exemplary employer.

The large Boiler and Radiator plant of the Gurney Foundry Company, Limited, is situated at West Toronto. In the opinion of experts, this plant is an ideal one, alike in the suitability of its position and in the admirable arrangement of its various manufacturing units.

The site covers approximately 12 acres of ground and the plant proper, consisting almost entirely of one-storey buildings of a modern type for foundry practice, covers approximately 6 acres. The foundry proper has an area of nearly 2 acres and is supplied with metal from three cupolas, one of which is the largest in Canada. Moulding machines are extensively used throughout in this department.

In order to supply a large plant of this type with core sand and iron, the most modern handling facilities have been installed. For example, the mixed core sand and oil are never touched by hand until they are in the coremaker's bench. This is a typical example of the "up-to-dateness" which characterises every department of this well-ordered plant.

The rough castings go to the cleaning and inspection rooms, which constitute a most important department, because it is essential that castings which are going to carry water and steam pressure in buildings shall be perfect.

Then the castings pass on to the machining and assembling department where vigilant inspection is continued, and then to the warehouse and shipping rooms. The whole plant is so arranged that raw material enters at one end and comes out at the extreme other end of the plant ready for shipment. There is a slight grade throughout the Plant so that the carrier system operates practically without power.

Its shipping facilities generally are good. They are of such a nature that eight or ten trucks could be handled at one time, while there are separate facilities or "docks" for the loading of trucks for local business.

As in the case with the Company's boiler and radiator plant at West Toronto, there is no lack of space about the stove plant at St. Laurent. The site in which St. Laurent plant stands covers approximately 18 acres, of which the buildings (some of which are one storey and others two, three and four storey) cover approximately 3½ acres. The moulding shop is elaborately equipped for the production of light castings by machine, and the press department is a model of its type for the production of stampings of all gauges used in Gurney stoves.

The cleaning, nickelling and assembling departments are extensive and have been so designed as to give a maximum of light to the worker. These departments are all very completely equipped for their respective purposes.

A recent development of the stove business has been the introduction of vitreous enamel, which is really glass fused into the surface of steel. Any colour may be produced, and as the finish is absolutely not affected by heat and may be cleaned as readily as any cooking utensil, it has become very popular. Further, the introduction of colour in this finish has made it possible to lend added attractiveness to a modern kitchen range— an attractiveness little dreamed of in days gone by. This vitreous enamel department occupies a separate building.

In addition to producing enamel for Gurney Stoves, the production of signs where a lasting result is desirable, has become an extensive department of this business.

*Extract from an article by A. R. R. Jones, which appeared in a recent issue of "Iron and Steel of Canada."

Iron Ore Mining at Melilla.—One of the consequences of the troubles at Melilla in Morocco will be the paralysing for a more or less extended period of iron ore mining in that region. Even when order is restored it will doubtless be necessary to put the plants into working condition again, which will take time and demand further outlay on the part of the interested companies.

The Manufacture of Rolls.*

By H. E. Dille.

Since chemical analyses of metals first were made, great progress has been recorded in metallurgical practice. The chemist and the metallurgist working in the laboratory and at the furnaces in mill and foundry have brought to light many important facts about metals and their proper treatment. Determining the composition of the metal by chemical analysis, the effects of various proportions of the different constituents were found by the aid of testing machines which record the tensile strength, ductility, resistance to shock, hardness and other physical properties. The microscope assisted in the study of microstructures, and with the information gained from this source the scientist has built theories to explain the characteristics shown under certain physical treatments and compositions. Much has been learned about the control of iron and steel, and the regulation of foundry practice now is directed largely by chemical analyses and physical tests of the stock and of the product. In addition to these aids, in certain branches of the industry, pyrometry also plays an important *rôle* in controlling the pouring temperature as well as in indicating the degree of heat in the annealing and core ovens.

FIG. 1.—SHOWING THE ARRANGEMENT BY WHICH BOTH FURNACES CAN BE TAPPED INTO THE SAME PIT.

It might seem simple to control foundry operations by the aid of these scientific instruments and methods so that the product is at all times near perfection. True, this is done to a large extent in many branches where the difficulties are not particularly severe, but in the production of certain lines of castings so many complications enter into the process that the causes have not been clearly and definitely traced. In these cases empirical rules have been worked out in the light of past experience and the scientific data is qualified and broadened by these rules. This is the case in the manufacture of rolls where the problems are mainly of a metallurgical nature, the moulding process being comparatively simple. The difficulties in the metallurgical side are caused by the large compact mass of metal setting and causing shrinkage strains and segregation. In the case of chilled-rolls, casting iron against a metal chill it is difficult to secure a perfectly smooth surface on the roll and to chill the metal to a definite depth. In controlling these factors, temperatures of melting and pouring enter into the problem to probably a greater extent than they do into any other line of castings made. The correct temperatures of furnace operation and for pouring the metal have been worked out on an empirical rather than a scientific basis.

Classified according to the metal in them, three general grades of rolls are made. These are the steel roll, the chilled-iron roll, and the sand-cast roll. Between the chilled-iron roll and the sand roll is the roll made partly in sand and partly in a chill. The chilled roll is divided into two classifications according to whether it is to be used for hot rolling or for cold rolling.

Steel rolls are made almost exclusively from acid open-hearth metal, while the majority of chilled-iron hot rolls are cast from air-furnace iron, and a small percentage of them are produced in the acid open-hearth. Chilled cold-rolls are made from both air-furnace and cupola iron. Reasons for the application of the different melting furnaces used in each case are shown in the detailed description of each class of rolls.

The chilled hot-rolls present the greatest difficulties of any of the iron rolls. One of the essentials distinguishing them from the chilled cold-rolls and the sand-cast rolls is the necessity for comparatively low sulphur content, which is usually kept below 0.08 per cent., but seldom goes below 0.05 per cent. This is one of the factors which precludes the use of the cupola for melting the iron for these rolls, as the danger of picking up an excessive amount of sulphur in contact with the coke in melting is too great. Sulphur in large amounts is objectionable in chilled hot-rolls because of its tendency to cause cracks in the roll when in use.

Manganese is kept between 0.2 and 0.3 per cent. This element in larger percentages tends to produce a sharp line with little mottle between the chilled and the grey sections of the roll. Manganese also decreases the depth of chill produced on irons which have otherwise identical compositions. In fact, the action of the different elements towards the chill are in a general way identical to their action on chilled car wheels. Some carbon is lost in melting and the rollmaker generally tries to produce a chilled hot-roll with from 2.75 to 2.90 per cent. carbon. Lowering the carbon to this amount closes the grain of the iron, but does not produce excessive shrinkage which would develop with lower carbon.

The composition of chilled hot-rolls made in the United States is quite in contrast with the Swedish practice. The Swedish rollmaker puts as much as 1 per cent. manganese in the roll and uses higher total carbon, ranging between 3.25 and 3.50 per cent. in the metal. Phosphorus, on the contrary, is kept low, averaging less than 0.05 per cent. This difference in the views of the rollmakers of the two countries indicates a divergence of opinion as to the effects of the different elements on the properties of the roll, or different mill practice, as an American manufacturer would not attempt to use as high manganese or carbon and would not think it possible to cast a roll with less than 0.05 per cent. phosphorus.

By melting in the air furnace, the total carbon is reduced and the sulphur content is kept down. The same effects can be obtained from the open-hearth furnace, but to handle the open-hearth

* Extracted from "The Foundry."

economically it must be operated continuously, and most roll foundries operate only during day turn. Another objection advanced by rollmakers against the use of the open-hearth furnace is that the metal must never be heated above a certain point during melting, and the open-hearth offers greater danger of the melter overheating the iron. It has been observed that if the metal is heated in the furnace above a certain point, the characteristics of the metal and its chilling properties gradually are changed.

The raw material used is the same whether the iron is melted in the open-hearth or in the air

FIG. 2.—END VIEW OF ONE OF THE FURNACES SHOWN IN FIG. 1.

furnace. Steel companies which have their own roll foundries return the discarded rolls to be remelted, and the independent roll manufacturer usually contracts to buy back a percentage of old rolls. Therefore, scrap rolls form one of the chief ingredients of the mixture. The total amount of scrap, including scrap rolls, heads, and runners used in the mixture varies from 40 to 70 per cent. of the charge. The largest percentage of the pig-iron is warm-blast charcoal. Some cold-blast charcoal pig iron is used, but recently manufacturers have been using a smaller proportion of this grade of iron on account of the high price. Cost also is a factor in inducing some rollmakers to use a small percentage of coke pig iron in the mixture. The importance attached to the pig iron used is illustrated by the fact that one company had a microscopic study made of a new brand of charcoal iron offered to them and would not adopt it on the basis of composition alone

In addition to the scrap rolls and the pig iron, the heads and gates must be remelted. The extent to which these heads enter into the mixture may be estimated when it is remembered that as high as 20 per cent. of the metal poured often is used in the gate and head.

Furnaces are placed in the foundry relative to the most economical charging conditions. Many furnaces are built so that one end is flush with the side of the building. In such cases the crane which covers the stock yard carries the metal for the charge to the furnace. Fig. 2 illustrates a furnace so placed. The crane carries the pig-iron and the smaller scrap to the charging platform in steel boxes, one of which may be seen at the right of the platform. In the illustration the furnace has been charged and the door which is handled by the crane has been closed and luted with brick and a mixture of sand and fireclay.

Another arrangement of the furnace is to place the two furnaces end to end. In this case the door is swung on a jib attached to the side. The charge is brought from the stock yard by cars on the industrial track laid between the furnaces. Heavy pieces are lifted off the cars by the chain hoist on the travelling I-beam crane between the two furnaces.

After a heat is taken off, the door of the furnace is opened and the slag is cleaned from the bottom. A new bottom is made the next day by spreading a layer of old burned core sand or some similar sand over the entire surface, slanting the bottom towards the tapping hole. Boards about 1-in. thick are laid over the entire bottom to prevent the charge from digging into the sand and forming pockets to hold the metal and prevent it from running out when the furnace is tapped. In this way only one heat a day can be taken from a furnace.

Various systems of charging the furnace are used. Some furnacemen charge pig-iron near the bridge wall, which is in the end opposite to the charging door. The heavy scrap is then placed near the door. This facilitates the charging operation. However, when a boom carried by a travelling crane is used for charging the furnace, it is comparatively simple to place the heavy stock in the far end of the furnace. In a few foundries a portion of the pig-iron is charged in the base of the stack.

Where the boom is not in use, other means must be provided for introducing the heavy scrap into the furnace. One method is to use a set of rollers, which is placed on heavy planks extending from the car into the furnace, and the roll or heavy riser, placed on top of it, is run into position in the furnace where the charge is pushed off the roller truck. Whatever the relative arrangement of the scrap and pig-iron may be, care always is taken to pile the pig-iron with the pigs in one layer at right angles to those in the next, and to leave space between the pigs in each layer, thus allowing the flame to penetrate around every pig. Heavy scrap is laid lengthwise of the furnace so that the flame sweeps along its entire length and has a free passage to the stack.

Practically all air furnaces in which iron is melted for rolls are heated with coal. Most of these are hand-fired, although a few are equipped with automatic stokers. Both forced draft and natural draft systems are utilised. One plan adopted with furnaces having natural draft is to have a comparatively low arch on the port leading to the stack. Then, as the bottom of the furnace is continuous with the base of the stack, the metal as it melts flows into the stack and gradually shuts off more and more of the opening between the furnace and the stack, thus decreasing the draft as the furnace heats. One method of firing a natural-draft furnace is by the melter handling a large spoon on which the fireman shovels the coal. The spoon places the coal evenly over the entire grate.

The metallurgist puts great stress on the melting process and each has his own views as to how fast the iron should be melted. Oxidation in the melting process carefully is avoided by the majority. After the metal is melted, it is thoroughly poled and a test sample is taken. In some cases the metallurgist is held responsible for the metal. He tells the melter how to treat the iron in the furnace and when to pour.

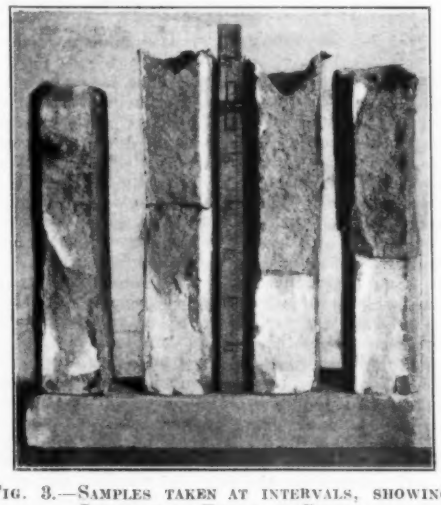

FIG. 3.—SAMPLES TAKEN AT INTERVALS, SHOWING INCREASE IN DEPTH OF CHILL.

The test pieces vary only slightly in dimensions at the different foundries. At one foundry a piece is cast in open sand 6½ in. high by 5 in. long and 1¾ in. thick. It has a small notch running vertically across its face in the centre. The sample is left in the sand to cool a definite length of time, in this case 10 minutes, and then taken out of the sand and allowed to cool to a cherry red in the air, after which it is cooled to nearly room temperature by thrusting it in and out of a bath of water. It is then broken across the centre, where it is marked by the notch. The water cooling is not

resorted to until the colour indicates that the temperature of the sample is below the critical point.

Controlling the Composition.—The first test usually shows too light a chill and it is frequently necessary to add ore to the bath to lower the silicon, manganese and carbon. After the ore has stopped working the bath is thoroughly poled and a second sample is taken. This will disclose whether it is necessary to make any more additions. Frequently all that is required is to leave the metal in the furnace a little longer. In addition to the ore, washed metal is often used for the same purpose, either by itself or with the ore. This metal having only traces of manganese and silicon with 3.5 to 4.0 per cent. carbon assists to increase the depth of chill in the iron rapidly. Usually four tests are taken before the heat is tapped. At many foundries a part of the first test is sent to the laboratory for the determination of carbon, silicon, manganese and sulphur. These are made in about half an hour after the test piece is drilled, which together with the 15 minutes required for cooling and drilling, make three-quarters of an hour for the test.

Controlling the Temperature.—When the eye indicates the heat is nearly up to temperature, heat tests are made either with a pyrometer or with a rod of low carbon steel or wrought-iron, which is done quickly. The metallurgist generally employs the pyrometer, while the rod test is favoured by the melter. This latter test is made by sticking a ½-in. rod in the furnace for a definite time, then pulling it out. The rod will be cut by the iron in the furnace, and if it is cut sufficiently to bring its end to a sharp point, the metal is judged to be hot enough. The pyrometer is more definite in its results and is proving of benefit to the rollmaker. However, the claim is sometimes made that the experienced melter has one advantage over the man who depends entirely on the pyrometer, in that he not only can determine the temperature but also judge conditions by the fluidity of the metal. In several foundries the optical pyrometer is used with apparent success and gives check readings by different operators, so that the main point necessary to secure accuracy is to be certain that it is at all times correctly calibrated and applied. Its proper application is essential, as for example in taking a reading of the temperature of the iron in a ladle a false result will be obtained unless the instrument is pointed at almost a right angle to the surface of the iron instead of at an obtuse angle with it.

The history of one heat is indicated in Fig. 3, which shows the four test pieces taken during the heat. The sample at the left of the illustration was poured at 11.30 a.m. and shows a 1-in. chill. As a 1⅝-in. chill was wanted, 150 lbs. of ore was added to the heat. This was allowed to work, and after the batch calmed it was thoroughly poled. Then at 12.15 p.m. a second sample was taken. This showed a 1¼-in. chill, as indicated by the second test from the left, Fig. 3. As this was approximately the depth of chill desired, the bath was again thoroughly poled after a short interval, and a third sample, which showed a 1½-in. chill, was taken. Twenty minutes later, after the bath was again poled, a fourth sample, shown to the right, Fig. 3, was poured. This had the desired chill and the heat was tapped at 1.20 p.m. The chill on the roll cast was ⅞-in. clear.

In deciding the proper time to pour, not only must the depth of chill and the temperature be considered, but the condition of the mottled surface of the test piece and the way the iron sets on the top of the test piece must be taken into account.

In all, about two hours usually are required after the iron is melted to refine the metal, get the proper depth of chill and the correct pouring temperature. The metal is then tapped into a ladle held in a pit by a crane. Fig. 1 shows an arrangement where two furnaces can be tapped into the same pit. In the illustration, wood is shown placed in the two long runners to dry them.

Usually the metal as it comes from the furnace is too hot to pour and is held a short length of time to cool until the correct temperature is reached, as found by taking pyrometer readings of the surface of the metal in the ladle. Experience has indicated the pouring temperature which gives the best results for each size roll and these temperatures are rigidly adhered to. Temperature readings are taken again as the metal is poured, and kept for record.

The metal is poured slowly until it rises in the mould to within an inch of the fillet of the neck, then it is poured as fast as possible. The time required for pouring the main body of the mould is kept within narrow limits and varies from 20 seconds for the smaller rolls to 60 seconds for the largest rolls.

The metallurgy of chilled rolls for cold rolling is similar to that of the chilled rolls for hot rolling except less care is taken to keep the sulphur content low, and therefore some foundries produce these rolls from cupola metal. In this case the total carbon will be higher than in metal from the air furnace, analysing about 3.5 per cent.

Sand Rolls.

Sand rolls which, of course, are not chilled, may be made from cupola iron as well as from air-furnace or open-hearth iron. As might be supposed, with greater leeway allowed, a larger variation is found in the composition of these rolls. Sulphur is sometimes found as high as 0.20 per cent. and seldom below 0.08 per cent. Phosphorus varies considerably, some rollmakers keeping it below 0.1 per cent., while others carry it around 0.5 per cent. Silicon is varied from 0.65 to 1.0 per cent., largely depending on the size of the roll, the smaller rolls having the higher percentage of silicon. On the other hand, the manganese content is kept within the same narrow limits as it is for chilled rolls; that is, from 0.2 to 0.3 per cent. However, even here exceptions are made and in some cases the manganese is run higher. The sand-cast roll also differs from the chilled roll in that as much as 10 per cent. steel may be used in the mixture. Chromium and nickel also are used as alloys in the iron, being introduced as ferro-chrome and metallic nickel or by a pig-iron carrying these two metals. More than 1 per cent. of either alloy seldom is introduced.

As has been said, steel rolls are practically all made from acid open-hearth steel except for one class, which is midway between the steel and the iron roll. This is the roll containing about 1.80 per cent. carbon, all of which is held in the combined state. In these rolls silicon, sulphur and manganese are varied within wide limits by different manufacturers, but the phosphorus is uniformly kept low.

The melting operator for the regular steel roll is similar to the standard open-hearth practice. Temperature is considered as important in making steel rolls as it is in the manufacture of chilled rolls. One difference, however, is observed. When the iron roll is poured the temperature can be taken, and if the metal is too hot, check readings can be made after the slag is removed from the top of the ladle, to determine when the metal is cool enough to pour, but the slag on the ladle interferes with taking check temperature readings after a steel heat has been tapped.

Carbon varies widely in steel rolls, which are ordered according to the amount of carbon desired in steps of 0.10 per cent. from 0.3 to 1.25 per cent. carbon. Silicon usually is kept between 0.25 and 0.30 per cent., and sulphur and phosphorus are maintained below 0.05 per cent. Manganese varies widely in different rolls, but generally is held around 0.65 per cent. Steel rolls were formerly made of carbon steel, but of recent years the alloy steel roll is becoming more widely used and many of the roll manufacturers have patented alloy rolls which are said to give superior service to the plain carbon-steel roll.

Alloys Used.

Various combinations are used in the alloy rolls. The elements used are nickel and chromium, either together or separately, and high manganese. One alloy is formed of nickel and chromium with high sulphur, the latter running up to 0.2 per cent. Titanium also is used in some rolls. The metal to interest the steel roll manufacturer most recently is molybdenum. This metal is being introduced in some foundries for alloying purposes.

Neither chilled nor sand-cast iron rolls are annealed in ovens, but they are allowed to self-anneal in the mould which is possible due to their great mass. Smaller rolls are allowed to remain in the mould until the morning after they are cast, while the larger rolls stay in the moulds a much longer time.

XUM

One of the big problems in the steel roll foundry is to get the roll to set quickly. One foundry puts pipe in the mould, and as soon as the mould is cast starts water through this system of pipes. As the pipes are placed in the sand parallel to the roll and completely around it, in lines a few inches apart, the roll is cooled uniformly by the flow of water.

Practically all steel rolls are annealed, generally in ovens at the foundry producing them. Occasionally large steel rolls are flask annealed, being allowed to cool in the flask as long as two weeks. One of two types of design of annealing oven generally is used, either the round or the long narrow rectangular oven. In the latter case, which is the one most frequently used, several ovens frequently are built beside each other in a pit and separated only by a thin wall of firebrick. Such ovens are fired from the ends Another type is built half in a pit and half above the floor level. In these ovens, which are fired by oil, the burners are arranged along the sides below the floor line. A crane covers all the ovens and easily can handle the loading and unloading of the rolls.

Annealing ovens are fired with oil, coal, or gas, depending on the locality of the foundry and the judgment of the management. Care is used in their design to insure an even heat throughout the oven. Heat usually is applied through ports just above the floor line, but another type of oven admits the heat under the floor, which is formed of checkered arches, and allows the heat to flow upward from all parts of the bottom. The arches are supported on brick piers, which are capped with steel castings to support the rolls which are laid on the castings. The heat entering from one side of the oven passes up through the floor, rises to the roof and passes across and down, leaving the oven through flues along the floor line on the opposite side to which it entered. Where the heat is admitted above the floor line, it is usually carried off through flues on the opposite end near the floor. Some ovens have burners and flues on both ends of the furnace, but the burners on one end and the flues at the other end are only used at one time, then by heating from the other end and reversing the flow of the heat occasionally, the two ends are kept at an even temperature. This is controlled by pyrometers, with which practically all roll annealing ovens are equipped.

Oxygen in Basic Bessemer Steels.*

By J. SEIGLE.

Results of oxygen determinations in basic Bessemer steels, before and after the ferro-manganese additions, have been outlined in articles by Messrs. Oberhoffer (February 7, 1918), and Von Keil (May 5, 1921), in "Stahl und Eisen."

The method employed was to pass a current of pure dry hydrogen over the sample in the form of turnings, heated to redness, and to record the loss of weight thus brought about by the reducing action of the hydrogen on the oxides of iron. Neither pure oxide of manganese nor silica is reduced and any oxygen so combined is not estimated.

Mr. Oberhoffer's results can be summarised by stating that after heating to 950 deg. C., samples from steelworks B., 0.049 to 0.075 per cent. before, to contain between 0.055 and 0.083 per cent. of oxygen before the ferro-manganese addition and 0.013 to 0.018 after the addition, and samples from steelworks B., 0.049 to 0.075 per cent. before, and 0.012 to 0.045 after the alloy addition.

According to the figures set out in the author's tables no relationship was shown in the case of steelworks A, between the oxygen content before addition and the manganese content of the metal at this stage, or again between contents of oxygen after the addition and the manganese content either before or after.

As regards steelworks B., without doubt there is a mistake in connection with the samples analysed, for the manganese contents of the samples labelled "before deoxidising addition" are of the order of 0.24 to 0.30 per cent., and those called "after deoxidising addition" are very slightly greater than 0.25 to 0.39 per cent.

* Translated from "Revue de l'Industrie Minerale."

Mr. Von Keit carried out his experiments both at 950 and 1,170 deg. C., and in the latter case found slightly more than double the quantity of oxygen. The tests were made from steels coming from nine different steelworks.

Again, no relationship is shown even at the higher temperature used when carrying out the experiments between the oxygen content and manganese either before or after the ferro-manganese additions.

The contents were round about 0.04 per cent. of oxygen for the tests at 950 deg. C., and 0.09 per cent. for those carried out at 1,170 deg. C. for samples taken before the ferro-manganese addition. They are of the order of 0.026 to 0.058 per cent. for tests at 1,170 deg. C. after adding ferro-manganese.

The author's tables show that no relationship exists between the manganese content in the liquid pig-iron charged into the Bessemer converter and the manganese content of the blown metal, nor in relation to the oxygen content.

Whilst the results are in themselves very interesting they throw but little light on the question of the influence of oxygen on steel or of manganese on the oxygen. Generally speaking the oxygen content is less after adding ferro-manganese, but beyond that there is little to be said.

A Note on the Costing of Cupola Mixes.

By R. W. L.

It is customary in some foundries to make out a monthly trading account showing the stocks of metal at both the beginning and end of the month. In one foundry up to the beginning of this year no aggregate total of metal was taken—no detailed totals of pig-iron and scrap being shown. From January of this year, however, it has been customary to separate these two items, and in order to save time stock was only taken quarterly, but the separate monthly stocks were arrived at by estimate, on the supposition that 50 per cent. of pig-iron and 50 per cent. of scrap were used, these being the proportions in which the metal was charged into the cupola.

When stock was taken at the end of March we found that we had considerably more scrap-iron and less pig-iron than was shown on the stock sheets. This, of course, is due to runners, risers and surplus metal, which is returned as scrap, and when remelted pig-iron is charged with it.

A test was taken in order to arrive at the proportion of pig-iron and scrap actually used, after allowing for the shop-scrap returned, and gave the following figures:—

	T.	C.
Pig-iron charged in cupola	3	10
Scrap do.	3	10
Total	7	0
Less runners, risers, etc., returned ...	0	18¾
	6	1¼
Less wastage, 7½ per cent.	0	9
Total weight of castings produced ...	5	12¼

Therefore the proportion of pig-iron used in castings produced is as 3 tons 10 cwt. is to 5 tons 12¼ cwts, or percentage of pig-iron used in manufacture of castings is 62.36 per cent. In this cast there was no metal left over at the end of the day. Had this been the case, the metal would have been returned as scrap and consequently the percentage would have been higher.

Thus for the purpose of checking stock it will be seen that one should allow approximately two-thirds of the weight of castings made to be pig-iron and the remaining one-third scrap-iron.

Formerly in costing, the average cost of metal was allowed, *i.e.*, if the pig-iron were bought at nine pounds per ton, and scrap at six pounds per ton, the cost of metal in the casting was allowed at seven pounds ten shillings per ton.

It will be seen from the test, however, that the actual cost was two-thirds of nine pounds, + one-third of six pounds, = eight pounds per ton.

XUM

Building a Natural-Draught Melting Furnace.*

By Charles Vickers.

It may be doubted whether the coke or coal-fired shaft furnaces used for so many years in melting copper alloys will ever be entirely superseded by the more modern forms of oil and gas-burning equipment, or by electrically-heated furnaces, because they are so well adapted to the requirements of small foundries handling a multiplicity of alloys, and of foundries whose output consists of castings of thin section, that require hot fluid metal in order to run them properly.

While the more modern melting equipment possesses advantages that weigh heavily when a large production of molten metal is demanded, and may show considerable economy when operated under such conditions when compared with the old-fashioned pit-furnaces; the latter, nevertheless, are frequently found in service in brass foundries, both large and small.

A natural draught furnace has an open ash pit and is simply a stove, either square or round in section, and from two to three feet in length. Because of the intense heat generated within the furnace it has to be lined with firebrick. The fire is supported by grate bars which may be single lengths of steel of square or rectangular section, or cast-iron grids. For convenience of operation the furnaces are usually placed in a pit, so that their tops are level with the floor of the shop, or some 10 in. above it. The furnaces are raised a varying distance above the floor of the pit to provide space for the ashes and clinkers to collect, and periodically these have to be removed; and to enable this to be done the pit must be sufficiently wide before the furnaces to allow the ashes to be shovelled from underneath.

The open space from the edge of the pit to the fronts of the furnaces has to be bridged over, and this is done to best advantage by cast-iron gratings which thus form a part of the floor of the shop, carrying it tight up to the furnace fronts and leaving no spaces into which the workers can stumble. It is very desirable that the tops of the furnaces and the gratings completely cover the pit. For this reason it is advisable to put square plates of cast iron on the top of the furnaces, as they leave no openings through to the pit below.

The cover of the furnaces may be either of cast iron or firebrick. The former has so many advantages over the firebrick that it will be used on the installation to be described here. When the furnace is operated the cover is manipulated to control the draught through the fires; when entirely or partly off, the air by-passes through the opening thus left instead of going through the fire, and the draught is checked and the metal is held back. The metal is melted in crucibles which are embedded in the fire by the simple expedient of placing cold fuel around them after they have been stood on a bed of glowing coals four or more inches thick, in the bottom of the shaft. It is important to place the crucible in the centre of the furnace, leaving a space of uniform width all around it to be filled with the coke or coal to the top of the crucible.

After the crucible has been "coked-up" it is filled with the metal to be melted, and on top of the metal some charcoal or a few blocks of hard wood should be placed. Then the furnace is closed by placing the cover over, and the fire is allowed to burn for a period of time, the length of which is regulated by those attending to the melting. On the expiration of this time the furnace is opened, the partly melted metal is eased and pushed downwards if any tendency to hang is detected, and more metal is added, together with a fresh supply of charcoal. It is usually necessary at this stage to replenish the fuel around the sides of the crucible, as it is very important no burnt-out spaces be allowed to form.

This operation is repeated at intervals until the crucible gets filled with partly melted metal; and careful attention is required during all the period of melting to keep down the temperature of the metal in the crucible to just above the melting point by timely additions of solid metal. The thing to be kept in mind is to get the crucible full, with metal just fluid and covered with a layer of charcoal, then when this is accomplished the fire can be urged by closing the furnace in order to superheat the metal to the casting temperature.

The time necessary to allow for this superheating is a matter of judgment on the part of the furnace tender, and will vary with the draught of the furnace and the skill with which it has been managed. When the metal has reached the proper temperature the fuel around the sides of the pot will usually be largely burned away; this is the ideal condition, and its attainment is also largely a measure of the skill of the furnaceman.

The tongs should be easy to adjust around the crucible when the metal in the latter is ready to pour; the less punching down of coke that is necessary to get at the crucible, the less injury will be done to its sides, and the more heats the crucible will stand. After the tongs have been adjusted around the crucible in small melts it is generally lifted out by two men and swung over to the skimming hearth from which, after the *débris* has been cleaned from the surface of the melted metal, it is carried to the moulds.

Types of Furnaces and Dimensions.

The furnaces described in this article are suited for a small brass foundry situated on the bare ground, a situation allowing a pit to be dug for the reception of the furnaces. The furnaces are designed to use No. 35 crucibles. Allowing 3 lbs. of liquid brass to the furnace number, these pots will contain 105 lbs. when new. The inside diameter of the furnaces is 15 in. A No. 35 crucible is $11\frac{5}{8}$ to $12\frac{1}{4}$ in. high, depending on the maker. The diameter at the top varies from $9\frac{1}{4}$ to $9\frac{3}{8}$ in.;

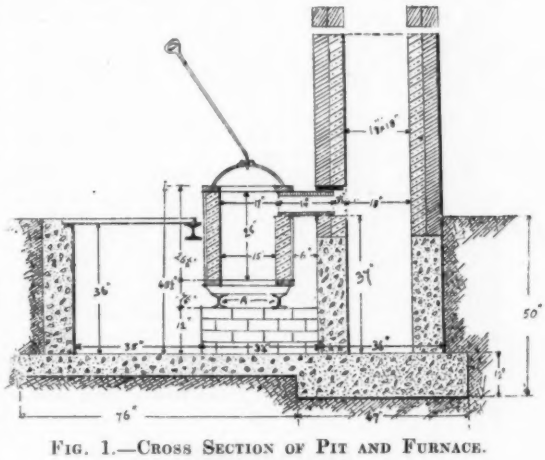

FIG. 1.—CROSS SECTION OF PIT AND FURNACE.

at the bottom from 7 to $7\frac{1}{4}$ in., and at the bilge from $9\frac{3}{4}$ to 10 in. Assuming 10 in. at the widest part, then a 15-in. diameter furnace allows $2\frac{1}{2}$ in. of fuel around the crucible. This permits of a fairly large sized piece of coke being put between the crucible and the wall of the furnace. It is an error to make the space between crucible and furnace wall too small, because in such case the coke has to be broken to small size, in doing which the wastage due to rust will offset the gain by reason of the smaller space for fire; also the draught will be impeded because of the small spaces between the coke, and the fires will not melt rapidly enough to avoid oxidation of the metal. A 15-in. furnace will "take" a No. 40 crucible also, especially after the latter has been used a few times, when it gets thinner. A No. 40 crucible varies at the bilge from $10\frac{1}{4}$ to $10\frac{1}{2}$ in. diameter. Thus the coke will require to be a trifle smaller, but the No. 40 can be depended upon to hold a heat of 100 lbs. of metal, even after it has been used a number of times. Nominally it holds 120 lbs. of molten brass or bronze, but not of aluminium.

We will assume that it has been decided to sink the furnaces in the floor of the shop to bring them

* Extracted from the July issue of the "Brass World."

to a lower working level, thus making it easier to operate them and to remove the molten metal.

There are two classes of pit furnaces, those that set level with the floor and those that do not set level with the floor. Which is better is a subject of controversy, being still a matter of opinion. The writer would rather work at furnaces set a little above the level of the shop floor in the case of small furnaces; it is not necessary to stoop so much; also when swinging out a pot by hand the swing is down grade to the skimming hearth and the pot is sufficiently high to clear any obstruction on the floor in its path.

Another point in the favour of above-floor-level furnaces is that the pit is not so deep; and while this may not cheapen the installation to any great extent, it is a matter to be considered when deciding how the furnaces shall be situated. If the ground is marshy and water is likely to seep into the pit, the shallower it is the better. On the other hand, furnaces set level with the floor make a better appearance; and if the furnaces are large and the crucibles are hoisted out by tackle, floor-level furnaces are the more convenient. In deciding the matter of floor-level or not floor-level furnaces appearances may be a factor; if the furnaces are set against a wall it will not matter greatly if they are level or not. If they are situated in a clear space central to the moulding floors, then they will look better and be less of an obstruction if both flues and furnaces are set level with the floor. Facilities for drainage must also be considered. Floor-level furnaces will require a pit at least 12 in. deeper than the above-floor kind. If it is a large pit, drainage to the sewer must be installed for safety; and the sewer must be considerably below the bottom of the pit. These are the matters to be considered when deciding whether the furnaces shall be set high or low. Another item is the matter of ashes removal; if they have to be thrown out on to the floor of the foundry it will be more difficult if using a deep pit. In the case of a large pit common sense will suggest the entrance to the pit should be made by means of an inclined runway from outside the shop. In this case the pit must be sufficiently deep and wide to permit men with wheelbarrows to enter and pass freely in front of the furnaces. This pit entrance must be closed by doors which are kept locked while the furnaces are working, as the ash pit of a battery of large furnaces is no place for men while molten metal is being transported above.

Many of the operations necessary to installing these furnaces can proceed simultaneously; in fact, it is necessary they do so proceed if the work is not to be unduly delayed. The furnaces will require some cast-iron parts; the patterns must first be made; also a boiler-iron shell will be needed for each furnace, and firebricks for lining and fireclay and sand for mortar. Cement and gravel and sand are needed for the concrete, common bricks for the walls of the flues and outside of the chimney. In this particular example we will use a brick chimney up through the roof with a sheet-iron extension on the top.

Question of Position.

The first matter to decide is the position of the furnaces, in which connection there are a number of things to be considered, a very important one being the fuel supply. Frequently a bin to hold a day's fuel supply is placed near the furnaces. This is filled by a labourer from the main coke storage each day. Sometimes a large two-wheeled iron truck is used for the coke, and there must be space for it to stand near the furnaces, and it must be so constructed the coke can be easily shovelled out for coking the crucibles. It is best made of sheet steel. The metal can be brought to the furnaces in sheet-iron boxes, each heat ready weighed in its box and marked with the number of the furnace in which it is to be melted. The furnaces with the tools, such as tongs, pokers, skimmers and shanks or carrying bars; the bins for coke and charcoal; the skimming hearth and the crucible storage, will require considerable space.

When the lay-out of the shop will permit the furnaces to be situated at one end, with the fuel and metal supply coming in at the same end, it will permit the work to be so planned it can be progressively carried forward to the other end of the shop, where it is shipped as a finished product. The moulding floors would thus be adjoining the furnace space; the fettling department would adjoin the moulding floors; the inspection and shipping departments would be at the outgoing end of the plant.

By this arrangement the raw materials, coke and metals would be received at one end and be stored, then going to the furnaces as wanted. The liquid metal would travel into the shop to the moulding floors; the castings would pass along through the operations of cleaning, grinding, sorting and inspection to the shipping department.

Building the Furnace.

After the position of the furnaces has been decided upon the work of building them can be started.

The principal cast-iron parts are shown in Fig. 2, and consist of a bottom and a top plate, a cover and a flue, to which may be added rectangular cast-iron plates for forming the roof of the brick flue extensions on either side the stack. The dampers are cut from sheet steel or they can be cast, as thought best. The top and bottom plates differ in that the bottom plate has two ribs cast on as shown. These ribs are 1 in. thick at the base, tapering to give plenty of draught to $\frac{3}{4}$ in. across the top. They are 2 in. high from the plate. The object of the ribs is to act as legs to raise the plates and provide a space between them and the rails on which the furnaces stand. This space is to allow the grate bars to be slid under the plate and rest at the ends on the supporting rails. As

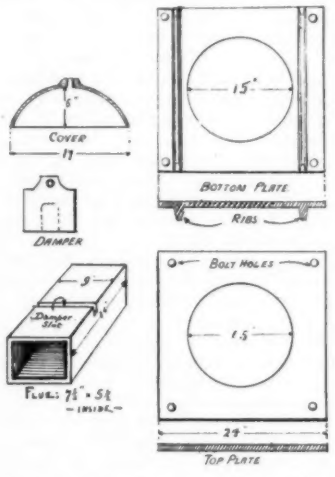

FIG. 2.—IRON CASTINGS FOR BRASS-MELTING FURNACE.

the ribs are 2 in. high the grate bars do not touch the bottom plate by about $\frac{3}{4}$ in. This arrangement gives greatly better draught to the furnaces, as this annular space is seldom clogged by clinkers, as are the grate bars when the furnaces are working. When the furnace bars come tight up to the bottom of the furnace, about mid-day the bars get clogged with clinkers, and if the fires are not dumped for the afternoon work and relighted with clean grates, the melting will be greatly delayed. Whenever difficulty is experienced in working natural draught furnaces, due to a slackening of melting speed as the day progresses, look to the bottoms of the furnaces, and note if the grate bars touch the bottom plates. Many hinged cast-iron grates are made so that when closed they come close to the bottom plate. When this defect is noted throw out the cast-iron grates and replace them with loose bars set lower down.

The pattern for the furnace plates should be designed to produce a casting 24 in. by 24 in. square by $1\frac{1}{4}$ in. thick. This plate has a circular hole in the centre 15 in. in diameter. The two ribs cross the pattern on opposite sides of the hole as shown. One pattern will make the two plates, as the ribs can be stopped off when the mould is made for the top-plate. If the pattern is of wood there would be no saving in making two patterns, one for the bottom plate and another for the top plate, because it would be necessary to put stop-off ribs on the pattern anyway, to keep it from warping out of shape. One pattern therefore does for the top and bottom plates. A second

pattern is wanted for a furnace cover, as shown in Fig. 2. This cover is dome-shaped, 6 to 8 in. deep, 17 in. outside diameter, with a metal thickness of $\frac{5}{8}$ in. at the circular edge, tapering to $\frac{3}{4}$ in. at the top of the dome. It has a boss on the crown with a 1-in. hole cast through, by means of which the cover is manipulated, using a $\frac{7}{8}$-in. steel bar of convenient length, which has a loop for a hand grip on one end, and the other end is slightly bent from the straight for about 2 in. The bent end is inserted in the hole in the cover. A pull given on the grip raises the cover partly on edge, permitting it to be easily rolled aside.

A third pattern is for the furnace flue. In these small furnaces this is made entirely of cast iron, but not lined with firebrick. In the case of large furnaces developing intense heat, a different flue

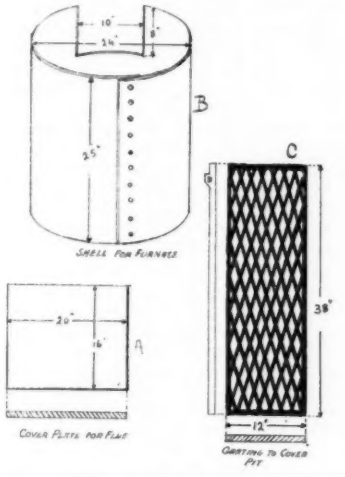

FIG. 3.—PARTS OF NATURAL-DRAFT FURNACE.

connection is used, one that can be lined with firebrick. Fig. 2 shows the cast-iron flue, not the pattern; the latter is made to mould with a core, and is a rectangular-shaped affair, 9 by 7 by 14 in. outside dimensions. The core-box must make a core $7\frac{1}{2}$ in. by $5\frac{1}{2}$ in., and long enough to fit the prints on the pattern. The damper slot can be planed across the casting, or it can be cast in either by a ridge on the core, or by a green sand ridge left by the pattern in the mould.

A fourth pattern is required to make covering plates for the brick flue extensions. This pattern, as shown at A in Fig. 3, is merely a rectangular flat plate 16 by 20 in., and about 1 in. thick. For a three-furnace installation this size is large enough for one plate to entirely cover each side of the top of the brick flues. A cast-iron plate forms the best covering for brass furnace flues. When the flue is long enough to require a number of covering plates, a tongue or overlap should be cast on one side; the length of the tongue is equal to the width of the flue inside, the plates being laid with the tongue downwards. The tongue closes the joint between the plates, so that fireclay can be inserted, as it is not advisable to set the plates metal to metal on account of expansion when heated.

Bricklayers prefer to arch over the flues with brick, as this operation requires time and means more work for them, but the iron plates make excellent storage space for crucibles. With a brick arch over the flue the weight of the crucibles would spring the arch sideways, and in time throw down the flue walls if they are not well braced.

A fifth pattern will be required for cast-iron gratings to cover the ashpit in front of the furnaces. A grating with diamond-shaped openings presents a neat appearance. The metal thickness of the bars should be $1\frac{3}{4}$ in. downwards, and the width should taper from $1\frac{1}{4}$ to $\frac{3}{4}$ in., to allow plenty of draft for the iron moulder.

The gratings are made 38 in. long and 12 in. wide, two gratings to a furnace. On the shop end the gratings overlap over the pit wall and fit into a recess made for them in the cement. On the furnace end the gratings rest on the top of an I-beam, as shown by the cross section in Fig. 1. To hold the gratings firmly in place it is a good plan to cast on the under side of each a small boss, which engages the edge of the I-beam and holds the gratings from slipping forward to the furnaces, which would slip the other end off the pit wall and might cause a serious accident. These gratings will span a pit 3 ft. wide. This is minimum width that will permit removal of ashes without inconvenience. If space and inclination permit, the pit can be made 4 ft. wide from the furnaces. This would leave the gratings 12 in. too short to span the pit. In this case it would be best to make them shorter instead of longer, as it will be necessary to put a second I-beam parallel with the first next the furnaces. If the gratings are then made 25 in. long instead of 38 in., two gratings end to end will span the pit if the second I-beam is located midway of the space. As the overlap on the pit wall should be 2 in., the gratings should be 25 in. long, and the centre I-beam should be set where the ends of the first row of gratings will extend half across it, and touch the ends of the second row. As the gratings are shorter they can be made lighter in section, and $1\frac{1}{2}$ in. thick by 1 in. to $\frac{5}{8}$ width will be sufficient. The centre I-beam must not be cemented into the pit walls at the ends; it must fit loosely in a socket at either end so that it can be lifted away as well as the grates when the ashes are removed.

Furnace Shell.—The furnace shell B, Fig. 3, is rolled from No. 14 sheet iron to a circle 24 in. inside diameter for this size of furnace. It is 25 in. high, and has a square gap cut out of one end for the flue as shown. It should be cut on a side remote from the riveted joint.

Furnace Supports.—To support the furnaces two rails are required; or I-beams may be used as shown at A, Fig. 1. These beams should be 76 in. long if rested on low walls, as shown in the cross-sectional drawing of the furnace, Fig. 1. Should it be decided to concrete the ends of these rails fast with the walls of the pit, the rails will need to be about 92 in. long, and must be placed in proper position when the concrete holding form is built. A length of angle iron is also required to face the ledge at the top of the pit wall where the ends of the gratings will rest. This angle iron should be about $2\frac{1}{2}$ in. face and 90 in. long. It is anchored to the concrete on the face of the ledge to prevent it crumbling and letting the grates drop.

Materials Required.—The materials required are cement, gravel, sand, firebrick, common brick, fireclay, silicate of soda, lime. If a sheet-iron stack is to be put up on the chimney it must be ordered at an early stage. If the brick portion of the chimney is 15 ft. high, projecting above the roof 2 ft., then a round sheet-iron stack, 18 in. diameter and 15 ft. minimum high, can be set on top of the brick. This minimum height of 15 ft. will answer provided the shop stands clear of other

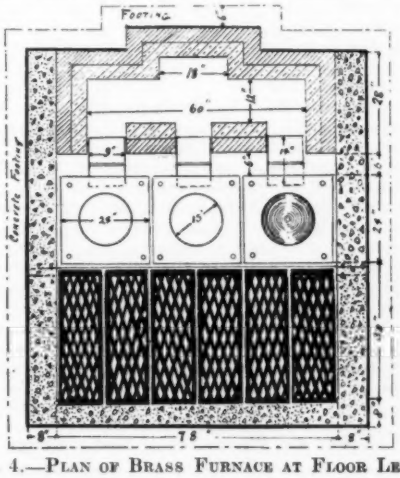

FIG. 4.—PLAN OF BRASS FURNACE AT FLOOR LEVEL.

and higher buildings. If high buildings are near the foundry it will be necessary to carry the sheet-iron stack sufficiently high to outtop them, otherwise production in that foundry will vary with the direction of the wind.

Pit Excavation.—The pit excavation is 7 ft. 10 in. wide by 9 ft. 8 in. long. The furnaces require more space forwards than sideways. This size of pit allows a 3-ft. working space in front of the furnaces, but this can be made wider as before

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outlined. The width of the pit is sufficient to allow three furnaces to be installed; for each additional furnace allow about 25 in., and if more furnaces are expected to be required later, one side of the pit can be made temporary, using planking to retain the earth, and facing the planking with a wall of single brick. The depth of the excavation is 3 ft. 6 in.; but at the bottom of the stack the earth is dug out 6 in. deeper for a square space, 4 ft. by 4 ft., figuring the footing. If the ground is firm this will be sufficient to carry a stack 30 ft. high, part brick and part sheet iron. The excavation will be a rectangular pit with straight sides. Before the concrete bottom is put in the walls of the excavation should be undercut 6 in. at the corners of walls and floor to allow of a footing for the walls, as shown in the plan, Fig. 4.

After the excavation has been made the floor is put in. This is made of concrete. It should be given a smooth surface to render the shovelling of ashes easy. In the case of small furnaces it is not necessary to cover the cement with bricks, but where the furnaces are large this should always be done, using hard burnt bricks. This precaution will prevent explosions of the concrete surface due to molten metal leaking from the furnaces on to the pit bottom. Using small pots, the mass of metal that might leak would hardly penetrate through the layer of ashes to the concrete. Fig. 1 shows the concrete part of the construction.

Sulphur and Phosphorus in Steel Ingots and Castings.

The chairman of the Committee A1 on Steel of the American Society for Testing Materials, announced at the annual meeting that regarding the much-discussed question of phosphorus and sulphur in the Society's specifications, the committee had given careful consideration to the note concerning these two elements which, by action at the last convention, had been allowed to remain attached to fourteen specifications, and that the committee had recommended that this note be removed from all specifications and that the sulphur requirement be raised 0.01 per cent. in four specifications and the phosphorus requirement for acid steel be raised 0.01 per cent. in one specification.

In explanation of these recommendations, the chairman pointed out that of the fourteen specifications that now carry the note, the note affects the phosphorus in Bessemer steel in the specifications for rails, splice bars, reinforcement bars, tie plates, track bolts, and the Bessemer grade in structural steel for buildings. The recommendation to remove the note from these specifications will require manufacturers to work to the original phosphorus limit for Bessemer steels.

Of the remaining specifications three cover rivet steel, original sulphur 0.045 per cent.; also the specifications for boiler tubes and seamless tubes call for sulphur 0.045 per cent. The effect of this recommendation would be to require manufacturers to adhere to the original 0.045 limit. Sulphur for steel chain was specified at 0.05 per cent., and this would again become the limit.

As against these changes cutting off the extension for sulphur and phosphorus, it is felt, stated the chairman, that the extension in sulphur from 0.05 to 0.06 per cent. in the three classes of structural steel must be retained due to the heavy tonnages involved and to the continued difficulty in obtaining low sulphur fuels and melting stock. The recommendation to continue the extension of both phosphorus and sulphur in steel castings is made in the belief that the same difficulties with fuel and melting stock exist in this industry.

Sulphur and Phosphorus in Steel Castings.

The chairman reported that the movement which originated in the American Society for Testing Materials for a comprehensive survey of the effects of phosphorus and sulphur in steel castings is well under way in the hands of a large and representative joint committee working under the chairmanship of the Bureau of Standards. The society is looking to that investigation for final advice as to suitable limits, but until the work is completed it is believed that the changes now recommended may be made with safety.

The committee recommended the revision of the heat treatment clauses in the specifications for steel forgings and billets. At present forgings are allowed to become cold after forging, and it is recommended that this be changed to read that forgings be allowed to cool only to a temperature below the critical range in order to prevent damage.

The complete report presents numerous revisions in standard specifications, and also proposed revised specifications for welded and seamless steel pipe as well as proposed tentative specifications for carbon steel rails and cold-drawn steel wire for reinforcing.

High-Test Iron.

Dr. Moldenke, chairman of the Sub-Committee A3 on Cast Iron of the American Society for Testing Material, at the annual meeting of the Society, submitted a report on the work carried out in connection with the general sentiment among engineers and foundrymen on "semi-steel." The Chairman stated that it was considered that the misleading appellation "semi-steel" given to a very useful form of cast iron should be done away with, and the material itself be standardised so far as this may be accomplished, by definite specifications for the physical properties usually designated.

The addition of steel scrap to foundry mixture, according to the report, dates back to the American Civil War, and, through the reduction of the total carbon, the strength of the resulting castings is enhanced considerably. The improvement is, however, one of degree and depends upon the percentage of low-carbon steel scrap added, and equally upon the metallurgical skill of the foundryman. Necessarily, the tendency to charge high prices for the product exists, whether much or little steel has been used, etc. It was recognised by the committee that two things must be done to accomplish the desired reform: First find a suitable designation for comparatively low-total-carbon grey-iron castings; and second, draw the line somewhere which will distinguish them from the ordinary classes of specification product. A name has been tentatively adopted for the want of something better, in "high-test" cast iron, and the committee is very earnest in inviting the members of the society who have experience with this class of castings to improve upon the designation here given. Sentiment against the word "semi-steel" as even a trade designation was unanimous. Specifications for this "high-test" cast iron are now under consideration, and it is hoped will be worked out during the coming year.

IMPACT TESTS OF STEEL CASTINGS.—A series of interesting dynamic tests on various grades of cast steels was embodied in a Paper by F. C. Langenberg, metallurgist, Watertown Arsenal, Watertown, Mass., entitled "Impact Tests on Cast Steel," and presented at the annual meeting of the American Society for Testing Materials. The Paper is based on some experiments conducted at the Watertown Arsenal to clear up some disputed points. Four separate experimental investigations are reported upon by the author, the first three covering steel castings and the last treating of impact tests on forged steel submitted for comparison with the results obtained from castings. The first investigation consists of a number of tests on the effect of phosphorus on the properties of Tropenas cast steel, which showed that a high phosphorus content greatly impaired the Charpy values. The second set deals with Tropenas steel castings, having a high manganese content, up to 1.75 per cent. A surprising increase in Charpy values with certain manganese contents was reported. The third series of tests covered the effect on Charpy and other values of varied heat treatments of acid open-hearth steel castings. In the brief discussion of this Paper Prof. H. F. Moore, University of Illinois, Urbana, Ill., raised the question as to what the significance of the results of Charpy tests really is since the conditions under which they are conducted represent abnormal service conditions, and bear no correlation to repetition tests of steel at low stresses.—"Iron Age" abstract.

Compression, Cross Bending and Shear Properties of American Malleable Cast-Iron.*

Compression is exactly the reverse of tension, and is a stress often applied to malleable cast iron, In products free from carbon, such as lead, mild steel and wrought iron, the elastic properties in compression are very nearly the same as those in tension. In cast iron the resistance to compression is considerably higher than that to tension, as may be expected from the fact that the graphite flakes completely enclosed in iron are less harmful under compression loads than to tension.

Ordinary cast-iron specimens fail in compression by shattering into fragments, usually with but little bulging at the centre. It therefore is possible to determine definitely the ultimate strength of a given specimen. The ductile metals, soft steel for instance, are not so definite in their behaviour. Instead of reaching a load where they fail completely by shearing on planes at 45 deg. to the direction of applied stress or by rupturing into fragments and ceasing to sustain any load, these ductile metals merely flow as the load is applied and never reach a point of complete rupture. Thus a cylindrical specimen of steel takes a barrel-shaped form, increasing in diameter and decreasing in length. The increased diameter

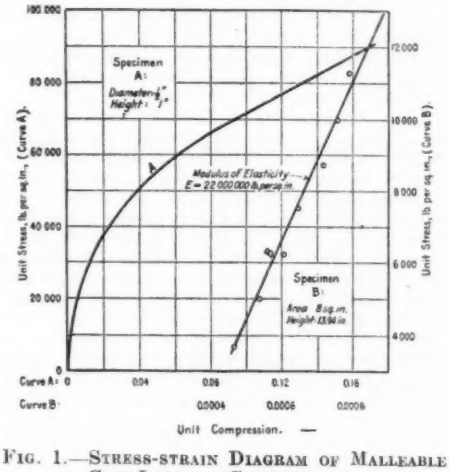

FIG. 1.—STRESS-STRAIN DIAGRAM OF MALLEABLE CAST-IRON IN COMPRESSION.

reduces the intensity of the applied stress and more load therefore can be applied. No actual point of failure can be established, but there is a limit beyond which distortion of a commercial detail would be equivalent to failure.

Malleable cast iron, being capable of great plastic deformation, behaves in this manner under compression, as indicated in the two stress strain diagrams shown in Fig. 1.

It will be seen that no definite point of failure can be found up to a load of 40 tons per sq. in. The permissible intensity of compressive stress depends therefore on the permanent set which can be tolerated. The graph readily permits of the selection of the load corresponding to any assumed condition of this kind. It will be noticed that there is the general similarity of the elastic constants in tension and compression. The proportional limit is 6.7 tons per sq. in. in tension and somewhere above 5.8 tons per sq. in. in compresion. The modulus of elasticity in tension is 11,160 tons per sq. in. as compared with 9,820 tons per sq. in. in compression. Therefore the material behaves in a manner very similar to soft steel under the two systems of loading.

Stresses in Columns.

The foregoing applies only to pure compression loads, which exist only in specimens in which the height is not much greater than the diameter. In longer columns it is practically impossible to keep the axis of the specimen exactly in line with the direction of load, the column springs out of line and the stresses become more complex. Tests on columns with fixed ends ⅛ in. in diameter and 10.6 in. high indicated that up to the proportional limit the modulus of elasticity is about 7,140 tons per sq. in. The fact that this figure is materially less than that obtained in pure compression would seem to indicate that even below the proportional limit the stress is not a purely concentric compressive one. In this column a very definite failure at 13.4 tons per sq. in. was observed.

The yield point is quite definitely marked at 11.1 tons per sq. in. Insufficient data are at hand to warrant the very definite acceptance of any special column formula for malleable cast iron. The columns tested have a ratio of length to diameter of about 17, and therefore are more slender than the average columns in actual use. Hence calculations based on an ultimate strength of 11 tons per sq. in. for strut details should be amply safe.

A well known formula for cast-iron columns with safety factor of 6 is:

$$\text{Safe load} = \frac{13{,}333 \times \text{area of column}}{1 + \dfrac{(\text{column length})^2}{266 \times (\text{diameter of column})^2}}$$

This formula is equivalent to the statement that the ultimate strengh for cast-iron columns is equal to

$$\frac{80{,}000 \text{ pounds per square inch}}{1 + \dfrac{1}{266}\left(\dfrac{L}{D}\right)^2}$$

The ultimate strength of the malleable columns tested was 13.4 tons per sq. in., the ratio L/D being 17. If a malleable column is subject to the same general laws as a grey-iron column, then to conform to the observed conditions the ultimate strength of a malleable column will be

$$\frac{62{,}000 \text{ pounds per square inch}}{1 + \dfrac{1}{266}\left(\dfrac{L}{D}\right)^2}$$

This formula applied to the specimens tested in pure compression would give a breaking load nearly 27.6 tons, at which figure the material was still carrying load but had badly deformed.

On the basis of a safety factor of 6 on which the formulæ were developed the safe crushing strength of malleable comes out 4.6 tons per sq. in., which is well below the proportional limit.

It is the writer's opinion that the foregoing formula can be safely used as a basis of design. The safety factor could probably be reduced readily to 5 and possibly to 4 without serious risk. For hollow cylinders Kidder uses the value 1-400 instead of 1-266 in the above formula; 1-500 for a rectangle and 1-135 for an equal armed cross.

Cross Bending Stresses.

When the material is used in the form of a beam, it is subject to cross bending stresses. This type of loading is very common in practice and is readily reproduced in a testing machine. The specifications of the American Society for Testing Materials before 1918 and of the United States railway administration provided for cross bending test results about equivalent to a modulus of rupture or apparent maximum fibre stress of 28.5 tons per sq. in. This value is decidedly too low to correspond to the required tensile strength. The modulus of rupture seems to be about twice the ultimate tensile strength of the product, the proportional limit corresponding to a fibre stress about equal to the ultimate strength in tension. While not absolutely exact quantitatively, the foregoing statements do express the general relationship. Thus a specimen cast from metal having a tensile strength of about 22.8 tons per sq. in. showed a proportional limit of 22.5 tons per sq. in., a yield point of 32.1 tons per sq. in. and a modulus of rupture of 50.4 tons.

Neutral Axis.

It is interesting to discuss why the modulus of rupture can be higher than either the tensile or compression strength of the material. When a

*Extroted from the "Iron Trade Review."

specimen is bent there is a tendency to compress the material on one side and to stretch it on the other. Somewhere between there is a so-called neutral axis where there is no change of length. In material in which the elastic behaviour in tension and compression is the same the neutral axis is midway across the section. The surface fibres of the specimen are strained most under such a condition, the compression or stretch decreasing—uniformly as the neutral axis is approached. As long as the material is perfectly elastic the intensity of stress, being proportional to intensity of strain, also varies uniformly each way from the neutral axis. Accordingly, the material behaves as a perfectly elastic body as long as the outer fibre is not loaded beyond the proportional limit. However, after that loading is passed part of the specimen is subject to plastic deformation. The intensity of stress then no longer varies uniformly from O at the neutral axis to a maximum at the top and bottom of the cross section, but there is a band of considerable width next to the upper and lower boundaries of the cross section in which the stress is fairly uniform. It is only below this area, where the stress is below the proportional limit, that the uniform decrease is observed.

The stress in the outer fibres is then not so great as would be calculated, since the permanent deformation of the specimen has transmitted some of the stress from the outer fibre to those further in. Therefore the modulus of rupture is a purely theoretical value not corresponding to any stress actually occurring in the specimen. It is merely the extreme fibre stress which would be produced at the breaking load if the material behaved as an elastic solid up to the breaking point.

In the cross bending tests a load of 700 lbs. at the centre of a 12-in. span produced in a ½ by 1-in. beam a deflection of 0.076 in. at the proportional limit. Up to this point the deflection of the beam has been elastic, hence the value of the modulus of elasticity can be readily calculated.

Letting W be the load = .312 tons
" X = deflection at centre = .076 inches
" L = span of beam = 12 inches
" B = width of beam = ½ inch
" D = depth of beam = ½ inch

$$E = \frac{W}{X} \cdot \frac{L^3}{4\,bd^3} = 14{,}192 \text{ tons per sq. in.}$$

The value is unexpectedly high both as compared with figures for the tension and compression experiments, and as compared with the value for steel, which is about 12,946 tons per sq. in. It is barely possible that the error is due to slight errors in the uniformity of D in the above formulæ. For purposes of calculation a conservative value probably would be below 12,946 and possibly as low as 11,160 tons per sq. in. to conform to the tensile results for the modulus of elasticity.

Shear and Torsion.

Shear and torsion are the two remaining static stresses to be considered. They are closely related with one another and involve the sliding of the metal on itself, the slip taking place along a series of planes within the material. Shear involves a linear displacement, while in torsion the displacement is angular. Rivets, bolts or pins are subject to shear when an attempt is made to slide the parts they hold together in a direction at right angles to the axis of the pin. It also is the shearing strength of a material which resists the punching or cutting in a die in a punch press. A knowledge of the shearing strength of malleable therefore is important, both in the design of shackle pins and similar details, and in the selection of punch presses to be used in fabricating the product. Determinations made by driving a punch of known diameter through a plate of known thickness and measuring the force exerted in a testing machine have shown the shearing strength of malleable to be about 20 tons per sq. in. Similar experiments made by shearing off a cylindrical pin (double shear) have values on the same metal of a little over 18.2 tons per sq. in. The first mentioned experiments probably are the more trustworthy. The experiments were made on metal having a probable tensile strength of 22.3 to 23.2 tons per sq. in. Therefore, the shearing strength apparently is about 15 or 20 per cent. less than the tensile strength of the product. In the case of elements in a design subject to twisting loads there is a tendency to shear not by a sliding motion of the planes within a solid, but by a rotating action, one plane over another as shown in Fig 2. Evidently the action is of exactly the same character in both cases. A twisting load is measured by the product of the force applied and its distance from the axis of rotation. This product is called the moment of the force about the axis of rotation or, more briefly, the torque, and is measured usually in

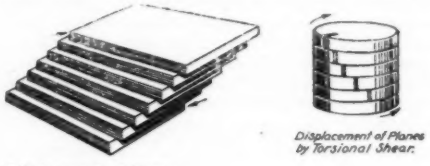

FIG. 2.—DISPLACEMENT OF PLANES BY LINEAR AND TORSIONAL SHEAR.

inch pounds. An inch pound is the moment of a force of 1 lb. applied 1 in. from the axis of the specimen. When a shaft is twisted the metal is evidently deformed or strained more at the surface than at the centre, the strain being proportional to the distance from the axis. As long as the metal obeys Hook's law of the proportionality of stress to strain—that is, as long as it is not stressed beyond the proportional limit—the stress also is proportional to the distance from the centre, and mathematical analysis will define the moment of torsional resistance of a section of given geometric form in terms of the dimensions of the cross section and of the shearing stress in the outside fibre.

When the intensity of stress in the outside fibre passes the proportional limit, a mathematical analysis of the load condition is no longer possible since the distribution of stress is no longer proportional to the distribution of strain. The modulus of rupture, or the apparent stress in the extreme fibre when breaking occurs, is higher than the true value since these layers stressed above the proportional limit carry a stress more nearly equal than their distance from the axis of rotation would indicate.

The condition is similar in character to that existing under cross bending stresses. Fig. 3 shows a stress strain diagram of the behaviour of the material in torsion. The load is recorded in

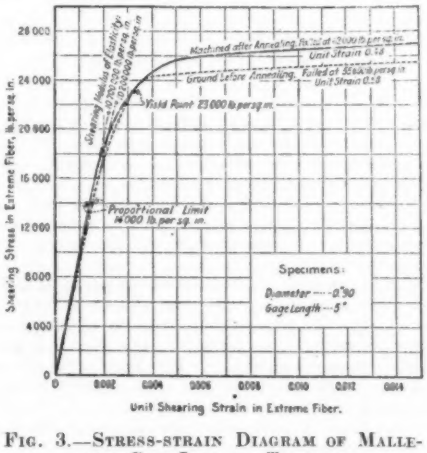
Shearing Stress in Extreme Fiber, lb. per sq. in.
Unit Shearing Strain in Extreme Fiber.
Machined after Annealing
Ground Before Annealing
Yield Point 23 000 lb. per sq. in.
Proportional Limit 14 000 lb. per sq. in.
Specimens:
Diameter — .930
Gage Length — 5"

FIG. 3.—STRESS-STRAIN DIAGRAM OF MALLEABLE CAST-IRON IN TORSION.

terms of intensity of shearing stress in pounds per sq. in. This is calculated from the known dimensions of the specimen and the measured torque. The intensity of shearing strain is determined in terms of the ratio of the linear displacement of a point on the surface to the gauge length. If within a gauge length of 5 in. a given load has produced a twist such that a point on the surface has advanced 0.07 in., the shearing strain is 0.07/5=.014. In other words the intensity of shearing strain is measured by the tangent of the angle through which an originally straight element of the cylindrical surface is displaced. Thus in Fig. 4, if W is the load and D its distance from

the centre, the torque is WD. S is the stress in the outer fibre L the gauge length of the specimen, F in linear measure is the displacement of the point by twisting under the torque WD from its original position, A. The intensity of the shearing strain is F/L, the value of F being determined from the known radius of the specimen R and the

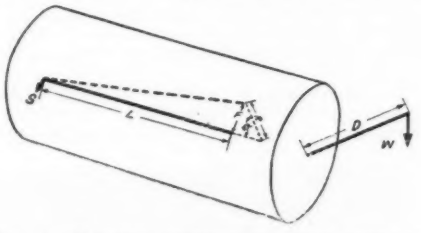

FIG. 4.—FACTORS ENTERING INTO THE QUESTION OF TORSIONAL STRESS.

angle O through which one end of the gauge length has been twisted with respect to the other. It will be seen from Fig. 3 that the proportional limits and yield points are not very different from those in tension and compression. The shearing modulus of elasticity, however, is not the same as Young's modulus. The course of the curve during plastic deformation is not very instructive, since it is considerably influenced by the testing speed. The preceding discussion summarises the available information with regard to the resistance of malleable cast-iron to the various well-known forms of static loading.

A New Method of Securing Chaplets.

By MICHAEL R. BURNS.

The device shown in Fig. 1 is one that has been found extremely convenient and a decided improvement over the ordinary method employed for securing chaplets in the cope of a mould. Usually a bar is placed across the cope at some distance above the top of the chaplet, the ends are clamped down and then the moulder inserts blocks or wedges between the bar and the top of the chaplet. It is a ticklish operation, and unless it is carried out carefully the movement or strain imparted to the core by the rising metal will dislodge the blocks and wedges and the result will be a shifted core and a scrap casting.

In the device shown in Fig. 1 there is absolutely no chance for the rigging to shift or slip. Only one application of the device is shown, but it can be adapted to fit practically any condition. Thus instead of a single bar it may take the form of a

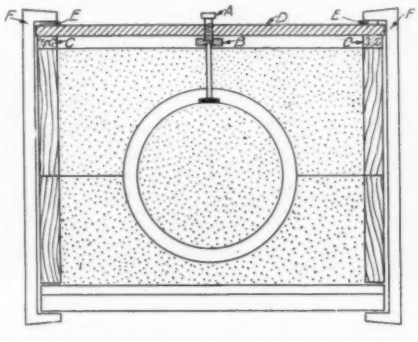

FIG. 1.—ILLUSTRATING THE METHOD USED IN SECURING CHAPLETS.

Y or a T or a circle, with chaplet holes drilled through it at as many points as the character of the cores in the mould require. Two or more clamps are employed to attach it firmly to the flask and then the bolts over the chaplets can be tightened down individually.

In the illustration the bar D, which may be of any width and thickness, depending on the size of the core it is intended to hold down, rests on the two blocks CC on top of the cope. It is held down by the clamps FF, which in turn are tightened by the wedges EE. The bolt A can be raised or lowered through a drilled and tapped hole in the bar D. The iron block B is drilled and tapped for about half its thickness on one side so that it can be attached to the bolt A, but the other side is only recessed about $\frac{1}{4}$-in. deep to receive the end of the chaplet stem.

In practice the bar is adjusted on the cope so that the bolt and block will come straight above the chaplet or chaplets. It is clamped in that position, and then all that is necessary is for the moulder to tighten down on the bolts until they feel tight.—"The Foundry."

The Stability of Conducting Electric Furnace Hearths.

As there is some indication that interest is being aroused in the electric furnace for iron foundry work, it is highly probable that the question of the reliability of conducting hearths will come up for consideration. Trouble has been experienced in the early days, both in the States and at home, but it can be confidently stated that such hearths are at least equal to non-conducting hearths, and according to one French expert, Monsieur Gillot, are superior on account of the cooler upper surfaces.

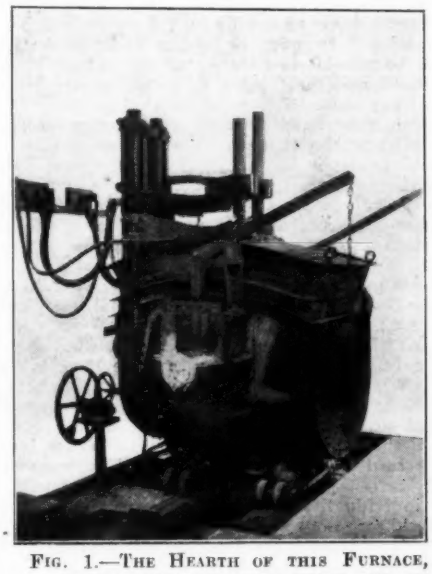

FIG. 1.—THE HEARTH OF THIS FURNACE, THOUGH INSTALLED FOUR YEARS AGO, IS STILL IN USE.

The permanence of the electric furnace hearth has been well demonstrated by the furnace shown in Fig. I. This furnace, which is of an obsolete type of Greaves-Etchells furnace, was installed in the works of a leading Sheffield steelmaker as far back as June, 1917. It has worked continuously with the production of many thousands of casts, yet the furnace is still operating, after four years on the original hearth. This gives every indication that a conducting hearth, when intelligently installed and maintained, is practically permanent.

Whilst this may constitute a world's record, many other results are extremely good, and substantiate to a large extent the assertion made in the last paragraph.

PLATE GIRDER SPANS FOR NEW ZEALAND.—The Public Works Department of New Zealand invites tenders until October 4 for the supply and delivery of plate girder spans for the Tarawera and Rangitaiki bridges. The estimated nett finished weight of the girders, including holding down bolts, is 200.88 tons. A copy of the conditions of tender (general and special), specification and blue prints in connection with the above has been received from his Majesty's Trade Commissioner in New Zealand, and may be seen by United Kingdom manufacturers interested on application to the Department of Overseas Trade (Room 50a), 35, Old Queen Street, S.W.1.

XUM

"Ferolux" and the Sulphur Problem.

Everyone knows that the great handicap to making a commercial success of a foundry is the number of chances there are of accidents. The production of flawless castings is dependent on so much human element from start to finish—knowledge and foresight in the choice of iron and mixture, degree of skill of melter and moulder are psychological factors that cannot be mechanically controlled—that surely it may be said that foundry work is more of a gamble than any other branch of engineering.

That is the reason why it pays the foundryman to adopt scientific methods—that is to say, systematic methods which make the probabilities of success a maximum. Science means exact knowledge, the very antithesis to gambling.

A field of research which is much neglected is the causes and prevention of wasters, both by the foundryman running the business and by the academic investigator. The tendency is to regard wasters from a fatalistic point of view as being, like the poor, always with us.

It is such a customary sight to see a barrow-load or so of wasters on their way to the scrap heap that in many a foundry they pass by without a glance on the part of the chemist, foreman or manager.

Wasters are unavoidable; but is the particular percentage turned out by each foundry possible of reduction? It may, by proper investigation, perhaps be possible to reduce that percentage by half or more, and thereby not only save money for the firm, but reduce labour.

How many foundries keep an accurate record of their wasters? It must be said, not so many as would profit by it. It does not involve much additional clerical work to keep, for instance, a record from week to week of the percentage of wasters and returns from customers to production on each particular job, without necessarily classifying the faults. In foundries who specialise in repetition lines, or where piecework is paid, scrap being deducted, it would not be a difficult matter. In the first place, it is easy to see from such a record which job is most profitable or otherwise.

Again, should the record of wasters on a particular pattern seem persistently high from week to week, investigation incited by such a record would probably show some defect in the pattern or method of moulding. If, on the other hand, the record on a given job fluctuated between high and low, the solution would probably be sought in the individuality of the moulder. Further, if the record for one week stood high on all or the majority of jobs, the fault would most likely lie with the iron. Indeed, so much can be deduced from a mere collection of figures regarding wasters that it amply repays the time expended in preparing them.

It is now the practice of most iron foundries to analyse their iron periodically, both pig and castings, in addition to the old-fashioned examination by fracture, and the benefits attaching thereto need no emphasis. For the purpose of watching wasters, however, the system is not complete unless some method is resorted to of marking the castings, on some part which is not machined, day by day, with letters or numbers to denote the day upon which a given article was cast. This can be done by the finishers with little metal punches on closing up the mould, or by means of a rubber stamp and white washable paint as the castings are despatched. Castings returned from customers can then often be identified as belonging to certain groups of wasters that sometimes occur, principally due to iron or wrong analysis.

Supplementing or superseding the above method of percentage wasters per article, it may be desirable to keep a classified percentage of wasters to total output, falling, say, under the following heads:—(*a*) Blowholes due to iron; (*b*) blowholes due to moulding; (*c*) scabbed and dirty castings; (*d*) hard castings; (*e*) porous and soft castings; (*f*) cracked castings; (*g*) miscellaneous faults.

It is not necessary to dwell on the majority of these faults, as they are easily recognised and remedied. For example, cracked castings are due either to rough handling or contraction while cooling, the latter cracks showing temper colours significant of where the remedy lies. Hard or chilled castings generally resolve themselves into an insufficiency of silicon in the iron or wet sand in the mould. Porous castings are due to either excess of silicon, *i.e.*, "open" iron, or to the method of running not admitting of natural "feeding" of the casting. The causes of scabbed, dirty or swollen castings are to be looked for in unskilled moulding, wrong sand or wrong method of running.

The above types of wasters are dealt with fully in many text-books; there exists, however, a prolific source of wasters, namely, blowholes, especially

FIG. 1.—SULPHUR PRINT OBTAINED FROM THE MACHINED SURFACE OF A CASTING SHOWING BLOWHOLES, THE DARKER ONES BEING CAUSED BY SULPHUR, WHILE THE LIGHTER ONES, MARKED A, ARE DUE TO TRAPPED GASES.

due to the iron, which deserves greater attention. Blowholes due to moulding are caused by the gases which are produced in pouring being trapped by the iron, and the remedy is to be sought in more open or drier sand or freer venting. These blowholes or trapped bubbles are usually recognised by their showing oxidisation tints. Blowholes whose cause lies in the iron are usually bright, occasionally contain pellets or shots, and are associated with excessive sulphur in the melt. It is by no means possible always to identify a blowhole as due to one or other cause by visual examination; a sulphur print gives the most practical indication.

Fig. 1 illustrates the manner by which the holes are differentiated, the "sulphur holes" being brought out as dark masses, and other trapped gases appearing as at A.

The microscope offers a certain means of identification of the trouble, but many foundries have not access to an instrument. The formation of a "sulphur hole," as shown in Fig. 2, is, however, interesting as being a micrograph of one of the

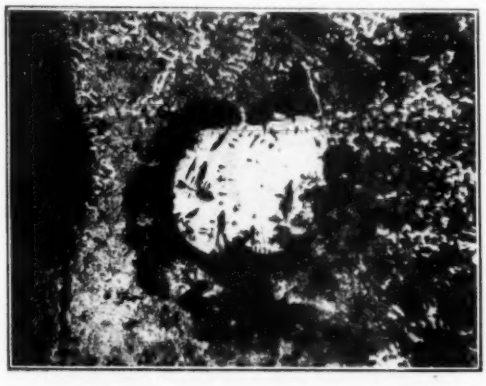

FIG. 2.—MICRO-PHOTOGRAPH OF A BLOWHOLE CONTAINING A PELLET OF MASSIVE PHOSPHIDE.

well-known holes containing a pellet or shot. The shot in this instance will be seen to be composed of massive phosphide, the sulphides lying all along the outer circumference of the hole. The bubble presumably contained sulphur gases given off by small particles of sulphides included in the liquid iron at the time of pouring the casting. The bubble rose in an endeavour to escape, but met with the solidified upper surface of the casting. Meanwhile, the iron surrounding the hole solidified, and the gases entered into combination with it, leaving ingress for the still liquid phosphide.

The origin of this hole was presumably gas generated by particles of sulphide in suspension in

the iron in the liquid condition; in other words, to excess of sulphur.

It is impossible in the short space of an article to dwell at length on this topic, but certain practical inferences may be drawn as affecting wasters.

The increase in sulphur in the castings is generally accompanied by decrease of manganese and gain in silicon. Here an analogy may be drawn between cupola practice and steel furnace practice in the influence of slag upon the molten bath. It is well known that a high silicate slag would precipitate silicon into the metal with an accompanying rise in sulphur and manganese, and, on the other hand, a basic slag reduces silicon and sulphur and increases manganese. The slag remaining on the iron in the cupola has a similar effect, and the sulphur blowholes are traceable to a cupola slag of too high a silicate degree and too poor in sulphur-dissolving constituents. The principal causes of such a slag are poor ganister and limestone, and perhaps an overworked cupola.

The remedy, or rather preventive, is to ensure that the cupola slag should lean to the basic side. This in practice involves frequent analysis of slag and care in selection of ganister and limestone. For the benefit of those founders who have not the facilities for a scientific control of the cupola, there has recently been placed upon the market a product called "Ferolux," and its action is based upon the foregoing principles.

Ferolux, which is a combination of minerals, is concentrated and compressed into cakes weighing about 4 ozs. each. Three of these cakes are sufficient to treat 5 cwts. of iron for a sulphur reduction of 0.04 per cent.

The material is made by the Ferolux Company, of 8, Central Chambers, Leamington.

Whether the foundryman possesses his own laboratory or not, the systematic or scientific investigation of wasters is a habit to be cultivated. It frequently produces a fund of unsuspected knowledge, not only of the lines upon which the business is being run, but also of the processes and phenomena that occur in the cupola and in the mould. It makes for economy and efficiency in every direction, and there is need, and will be greater need, for these qualities in the international competition that is bound to arise in the future.

Large Cores for Turbine Castings.

Steam-turbine castings for two scout cruisers, involving large core work, were a feature of after-the-war work of the Farrell Foundry & Machine Company, Ansonia, Conn. They were made by the Fore River works at Quincy, Mass., of the Bethlehem Shipbuilding Corporation, Limited. During the war the Farrell Company delivered considerably more than 100 of these castings to the shipbuilding company, and as a result of this war work was awarded the 1921 sub-contracts. Each scout cruiser is equipped with four shafts, and each shaft has one high, one intermediate and one low pressure turbine, making a total of twelve turbines to each vessel, and necessitating twenty-four castings, having a total approximate weight of 100 tons.

The steam-turbine castings presented difficulties on account of their size and the danger of damage to cores in assembling. The cores were set by measurement. The final coring up was difficult, because the bottom core prints were relied on to eliminate trouble during the lowering of the drag and cheek on the cores. It invariably was necessary to true up the larger cores by rocking, allowing fine sand to run in under the core during this process. In the case of the low-pressure turbine castings, illustration of which is shown, there were eight cores in the upper half and nine in the lower.

The average thickness of the castings was $\frac{7}{8}$ in. and the weight approximately 8,200 lbs. They were required to pass Government inspection before leaving the foundry. Specifications called for a transverse strength of 2,200 to 2,800 lbs. per sq. in. and a tensile strength of 3.9 tons per sq. in.

In making the main cores the core box was set up on a plate, rammed up and bound by cast-iron arbours. These arbours were provided with five hooks, which were screwed into nuts cast in the bottom of the arbours. The cores were picked up green, slicked up with a stiff blacking, placed on the oven car and thoroughly baked. After baking they were set up, preparatory to casting, the hooks were removed, and the resulting holes were filled with sand and smoothed over. The large cores were made by the same method, only fewer hooks were used. Small cores were made in the usual manner.

Each core, after being set in place, was carefully slicked to eliminate chipping of the finished casting. In view of the nature of the work there were few fins.

All inside surfaces of the castings, especially those in which the turbine blades operate, were machined at the Fore River works, but the amount of stock removed in this operation was slight. Machining was for the purposes of removing any particles of metal that might affect the course of the steam through the turbine. On the cope side of the machining surfaces an extra finish was allowed to take care of any dirt, but, aside from this and the flanges, little machining on the outside of the castings was necessary.

In this practice the drag is laid down and levelled and the bottom swept up 4 in. below the joint of the flask. The bottom flange is then laid down on the swept space and rammed up level with the joint of the flask. There, the parting is made. A cheek is next laid down 18 in. deep, and arbours, cast to fit inside the flask $\frac{1}{4}$ in. to $\frac{3}{4}$ in. away from the pattern, are laid in and hooked up to the top of the cheek. The cheek

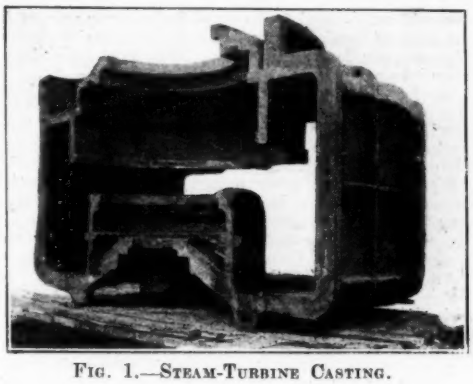

FIG. 1.—STEAM-TURBINE CASTING.

is then rammed up to the joint. Another is placed to complete the height of the flask to the top level of the pattern. These two cheeks are clamped together and the second rammed up to the joint, where parting is made. The cope, 10 in. deep, is then rammed on top of the cheek and pattern.

The cope is next taken off and the cheeks lifted complete, leaving the heavy pattern lying on the bottom of the flask. The moulds are then slicked up with a very stiff blacking and placed in ovens, where they remain about 42 hours. As a rule the arbours are not broken after casting, as the workmen exercise care in extracting them from the sand. The flasks are 7 × 9 ft. inside measurement.

In assembling, the drag is placed in a pit approximately 20 in. deep dug in the casting floor. The cores are then placed and anchored with chaplets. The cheek is then lowered into place and the cope set on, the whole being securely clamped down. The time consumed in making ready the flask for pouring is about three days. The flask is weighted down 14 or 15 tons just before pouring.

The patterns are made of $1\frac{1}{2}$ in. white pine, and require approximately 10,000 running feet of stock for a set of four patterns and the necessary core boxes. Those in use at Ansonia were made by the Hartford Pattern & Model Company, Hartford, the time consumed in this work being about two and one-half months. At the Fore River works, the upper half of the turbine castings are braced by seven $1\frac{3}{4}$ in. staybolts, and the lower half by one. In both instances the bolts are provided with inside as well as outside nuts to guard against internal and external collapse. The two castings are held together by $1\frac{1}{4}$-in. bolts. —"Iron Age."

XUM

Trade Talk.

THE EBBW VALE STEEL, IRON & COAL COMPANY, Limited, restarted a numer of mills on Monday.

DAVID COLVILLE & SONS, LIMITED, have transferred their head office from Motherwell to 195, West George Street, Glasgow.

IT is reported that the Argentine Legation in London has been authorised to buy in England a quantity of nickel for the Argentine mint to a value of 9,400,000 pesos.

THE SHIPYARDS on the Wear of John Blumer & Company, J. Priestman & Company, W. Pickersgill & Sons, and R. Thompson & Sons, Limited, have been reopened.

A PLAN is being considered for the construction of plant on the western coast of India to produce, from bauxite, about 2,500 tons of aluminium a year by the use of electricity.

LICENCES UNDER the Non-Ferrous Metal Industry Act, 1918, have been granted to Mr. F. Eve, 727, Tower Buildings, Liverpool, and R. Wolff & Company, 36, Lime Street, London, E.C.3.

A REDUCTION of 10 per cent. on the substantive wages which were paid on January 1, 1921, will be introduced in the Swedish ironworks from September 12. This will affect all the workmen who have no contract.

THE Prince of Wales has written to the hon. secretary conveying his best wishes for the success of the Engineers' Club, which, as already stated, opens its premises in Coventry Street to-day, September 1.

THE Newcastle sitting of the Court of Arbitration, appointed by the Ministry of Labour to consider the national question of the standard ship cycle wage advances, granted during the war, will be held this week.

IT is officially announced that the U.S. Steel Corporation will recommend to its subsidiaries a general cut in the rates of day labour to 30 cents per hour, as against 37 cents per hour at present. This new scale is to come into operation on August 29.

IN the Shetland Isles experts are reported to have proved a large and valuable find of copper ore, which should prove of immense service to North of England smelters, as it can be conveyed by sea at small cost. The ore field is adjacent to Lerwick.

UNITED WATER SOFTENERS, LIMITED, Imperial House, Kingsway, London, W.C.2, announce that they are the sole agents in the United Kingdom for the Sharples super-centrifuge, manufactured by the Sharples Specialty Company, of New York.

AN arbitration board, under the Industrial Courts Act, opened its sittings at Glasgow last week to deal with the wage dispute between the Shipbuilding Employers' Federation and various trade unions, embracing riveters, platers, shipwrights, and blacksmiths.

A LARGE number of riveters employed on the erection of the Admiralty oil tanks at Portland have ceased work. The men are members of the Boilermakers' and Iron and Steel Shipbuilders' Association, and are opposing a reduction in wages of 15 per cent.

THE German Government has submitted a Bill amending the constitution of the Iron Industry Syndicate. The Bill gives the syndicate greater independence of the Ministry of Industry and increases the number of representatives of consumers in the syndicate's governing council.

A U.S.A. report states that one million dollars, in addition to 2c. a pound royalty, is paid by the United States Steel Corporation to Walter Bunton (28), an overseas veteran, with a wound stripe, for his process of tempering copper—a lost art since the days of the ancient Egyptians.

THE NEALE MAGNET CONSTRUCTION COMPANY, LIMITED, 7, Suffolk Street, Pall Mall East, S.W.1, gave a demonstration of their apparatus at the Royal Albert Docks, last week, the object being to prove the adaptability of the Neale submarine magnet to salvage operations.

THE British Association for the Advancement of Science, in its meetings at Edinburgh this year, will revert to a custom which has latterly been in abeyance and will spread its deliberations over a complete week—from Wednesday, September 7, to Wednesday, September 14 inclusive.

RECENTLY Sir William C. Gray, Bart., formally handed over to the Council of Gray's Recreation Association the private residence known as Staincliffe, situated on the sea front at Seaton Carew, which he has equipped as a convalescent home for the use of the employés of the firm.

A CABLE message from Pittsburg, Pa., states that contracts for a million tons of German steel have been placed in America by Hugo Stinnes' interests. According to an announcement made in Pittsburg by a representative of the Deutsch Bank, German makers are considerably under-selling in the American market.

A SUPPLEMENT of the Agence Economique et Financière announces the formation in America of the Copper and Brass Research Association. The Association is described as a voluntary organisation of the copper, brass and copper alloy interests, whose purpose is to stimulate by co-operative effort the use of those products.

OWING to labour troubles and other causes the shipbuilding industry in Leith is at present exceptionally quiet, and prospects for the winter are far from reassuring. Repairing, on the other hand, is plentiful, and hundreds of shipyard workers are being kept pretty well employed. Half-a-dozen steamers are under repair.

UNDER the sliding scale agreement, based on the cost of living figures, between members of the Brass Employers' Association and the brassworkers and metal mechanics, an advance in wages was paid on Friday last, the cost of living having advanced from 119 points to 122 points. The increase payable will be at the rate of ¼d. per hour.

THE Government of Yugo-Slavia is credited with the intention of placing large orders in Germany in connection with the reconstruction of the railways. Apart from structural work for bridges, the deliveries contemplated are said to include 450 locomotives, 700 passenger coaches, 3,000 covered goods wagons, and 3,000 open trucks.

THE situation of the iron and steel industry in the Saar district has become critical owing to high wages, which have to be paid in francs, dear fuel, and other enhanced expenses; remunerative working is therefore out of the question. Many men have been discharged, and existing wage agreements have been terminated by the Röchling Company.

AT a meeting of the Privy Council, held at Buckingham Palace on Wednesday, August 10, the petition of the Institution of Electrical Engineers for a Royal Charter of Incorporation was approved, and a Royal Charter has now been granted. His Majesty the King has also been graciously pleased to intimate his willingness to become Patron of the Institution.

THE NEW sports ground, which constitutes the latest development of the men's and boys' welfare sections of the athletic club associated with Messrs. Alfred Hickman, Limited, Steelworks, Wolverhampton, was recently opened by Mr. C. E. Hickman. Mr. Hickman was afterwards presented with a silver gilt key, suitably inscribed, by Mr. Hedley Griffin, on behalf of the Athletic Club.

THE Centenary of the Independence of Brazil will be celebrated at Rio de Janeiro in the autumn of next year. In connection with the celebrations there will be an extensive Brazilian National Exhibition, and also an International Exhibition, and a number of nations have been invited to participate and many of them, it is understood, have already accepted the invitation.

CLAYTON WAGONS, LIMITED, have received orders for 100 oil-tank wagons of 14-ton capacity for Shell Mex, Limited, and the British Petroleum Company, Limited, and for 250 four-wheeled tip-wagons for the Bombay Back Bay Reclamation Works. Clayton & Shuttleworth, Limited, have secured an order for 16 locomotive boilers for the Madras and Southern Mahratta railways.

THE Ministry of Agriculture and Fisheries have published a report prepared by Mr. G. B. Wilson, with a contribution by Dr. J. G. Platt on the lead, zinc, copper, and nickel ores of Scotland. It is the seventeenth memoir issued by the Geological Survey under the general title of "Special Reports on the Mineral Resources of Great Britain." The volume is issued from the Ordnance Survey Office, Southampton.

AT the monthly meeting of the Belfast Committee of the Engineering and Shipbuilding Trades' Federation, consideration was given to Messrs. Harland & Wolff's sliding scale scheme for the future negotiations of wages based on the cost of living. After a protracted discussion, it was decided to submit a committee's proposal to the firm, and suggest a conference for joint discussion of same with the view of coming to a satisfactory settlement.

THE RESULTS in the ballot vote amongst the engineering and cognate unions on the proposed wages reduction have been officially issued to members concerned as follow:—Amalgamated Engineering Unions, 71,862 for, 63,624 against; Societies affiliated to B. and S. Federation, 43,016 for, 21,394 against; National Union of Foundry Workers, 17,989 for, 5,241 against; Societies affiliated to National Federation of General Workers, 42,278 for, 18,710 against; totals, 175,145 for, 108,969 against.

THE Shipbuilding Employers' Federation have intimated to the Federation of Engineering and Shipbuilding Trades that as an Order in Council has been passed declaring the official termination of the war as at August 31, it is intended to discontinue from September 1 next the Ministry of Munitions bonuses of 12½ per cent. to timeworkers and 7½ per cent. to pieceworkers. In acknowledging the receipt of the notice, the Unions assume that it will not be given effect until a conference of employers and employés has taken place to consider the question. It is understood that the employers have agreed not to discontinue the bonuses until such a meeting has been held, and arrangements are in progress for the holding of one early in September.

Company News.

Crossley Brothers, Limited.—Interim preference dividend paid; no distribution on ordinary.

George Johnson & Company (Birmingham), Limited.—Capital £40,000 in £1 shares, to carry on the business of metal manufacturers.

Summerlee Iron Company, Limited.—Ordinary dividend, 5s. per share, free of tax; interim dividend not disclosed; carried forward, £10,680.

Roper & Wreaks, Limited.—Capital £3,000 in £1 shares, to carry on the business of engineers. Registered office: 112, Arundel Street, Sheffield.

Blaw Knox Company, Limited. — Capital £1,000. Founders, engineers, etc. Directors: A. C. Lehman (chairman and permanent governing director).

London Smelting Company, Limited. — Capital £25,000 in 20,000 8 p.c cumulative participating preferred of £1 and 100,000 deferred shares of 1s. Registered offices; 16, St. Helens Place, E.C.

Furness, Withy & Company, Limited. — Profits, including balance brought forward, £955,848; depreciation account, £300,000; ordinary share bonus, 5 per cent., tax free, making 10 per cent. for year, tax free.

Walter Scott, Limited.—Profit, £47,006; surplus on provisions for Government duties in previous years, brought into account, £35,594; final ordinary dividend, 5 per cent., making 7½ per cent. for year; carry forward, £10,826.

Humber Graving Dock & Engineering Company, Limited.—Available, £14,728; reserve, £1,136; excess profits duty, income tax, and corporation profits tax, £4,000; final dividend, 6 per cent. per annum, making 5 per cent. for year; carried forward, £592.

Cheshire Pooley & Company, Limited. — Capital £5,000 in £1 shares, to take over the business of weighing machine, etc., manufacturers, carried on at 25, Bath Street, Liverpool, by Cheshire Pooley & Company. Directors: W. S. Pooley, J. R. Chater, and W. W. Wilding.

Whitley Partners, Limited.—Capital £35,000 in £1 shares, to take over the business of engineers, valve makers, and brass founders carried on by C. Close, at the Railway Works, Hunslet Road, Leeds. C. Close is permanent governing director. Registered office: Railway Works, Hunslet Road, Leeds.

Blagg & Johnson, Limited.—Capital £50,000 in £1 shares (30,000 8 per cent. preference and 20,000 ordinary), to take over the business of manufacturers, etc., of iron and steel pipes, etc., carried on by Emily Blagg and E. M. Johnson, at Newark-on-Trent, as Blagg & Johnson. Directors: Mrs. E. Blagg (managing director) and F. M. Johnson. Registered office: Beacon Bridge Works, Newark-on-Trent.

Gazette.

THE TANGENT TOOL COMPANY (COSMOS), LIMITED, are being wound up voluntarily, with Mr. T. W. Ellis, 110, Victoria Street, Westminster, London, S.W.1, as liquidator.

MR. W. J. D. PARSONS, Guildhall Buildings, Navigation Street, Birmingham, and 23, Dale Street, Leamington, mechanical engineer and machinery merchant, has been adjudicated bankrupt.

THE KENTISH SHIPBUILDING AND ENGINEERING COMPANY, LIMITED, are being wound up voluntarily. Mr. A. O. Nicholson, 841-842, Salisbury House, London Wall, London, E.C.2, has been appointed liquidator.

MESSRS. F. B. READ, 2, Little Heath Road, Foleshill, and T. Lindsay, 5, Walsgrave Road, Coventry, trading at 10, Vicar Lane, Coventry, as F. B. Read, engineering and motor factors, have been adjudicated bankrupts.

HUDSON'S ELECTRICAL ENGINEERING COMPANY, LIMITED, Leeds.—It was resolved August 9:—That the company be wound up voluntarily. Mr. W. Emmerson, liquidator.

BRITISH PHOSPHORISING AND CASTING COMPANY, LIMITED.—A petition for the winding up of the company has been presented by Mr. H. J. P. Morgan, 1, Salisbury Road, Handsworth, Birmingham, contractor. Hearing, County Court, Birmingham, September 15, at 10.30. Messrs. Wright & Marshall, 86, New Street, Birmingham, solicitors.

Steel Refining Works are to be established at the Yien Poo Tan, Pootung (China), by a Shanghai merchant.

Sir Thomas Wrightson, Bart., Neasham Hall, near Darlington, ironmaster, at one time M.P. for Stockton and East St. Pancras, chairman of Messrs. Head, Wrightson & Company, Limited, bridge builders, and a director of the North-Eastern Steel Company, Limited, a J.P. and D.L. for the county, who died June 18, aged 82 years, has left unsettled estate of the value of £212,074 5s. 6d., the net personalty being £91,881 18s. 6d.

The Census, 1921.

The Preliminary Report of the Census of England and Wales has just been issued. Apart from tables of the population enumerated in England and Wales (Administrative and Parliamentary Areas), and in Scotland, the Isle of Man, and the Channel Islands on June 19/20, 1921, the Report gives no information relative to the various industries, but points out that in one form or another it is intended to issue numerous other statistics including tables showing the numbers employed in various occupations and industries respectively, classified according to age, marital condition, and industrial status (*e.g.*, employer, employed). In addition, tables will also be given showing the various occupations covered by each industry and the numbers of people engaged therein.

In taking the Census, special attention has been given to the inquiries as regards occupation and industry with a view to securing an improvement in the statistics derivable therefrom. It appeared clear from experience of the 1911 results that a fuller and more scientific classification both of occupations and of industries than had hitherto been available was essential to the proper statistical treatment of this subject, and to the utility of the Census results for comparison with the Census of Production. The Census Joint Committee accordingly arranged for the subject to be considered by a special Sub-Committee, assisted by representatives of the Board of Trade, Home Office, and Ministry of Labour. This body, working with the co-operation of the Departments mentioned, drew up occupational and industrial classifications which have been adopted for the purpose of the Census returns; and it is understood that those Departments have expressed their intention of conforming to these classifications for the purpose of their own departmental statistics. Thus the actual achievement in this respect has gone beyond the immediate object of facilitating the Census work and has secured a valuable advance in the co-ordination of official statistics by providing standard classifications to which the Departments mainly interested have agreed to adhere.

Publications Received.

"THE JOURNAL OF INDUSTRIAL WELFARE, AUGUST, 1921." Price 9d. The Indutrial Welfare Society, 51, Palace Street, London, S.W.1.

METROPOLITAN-VICKERS ELECTRICAL COMPANY, LIMITED, 20, Brazennose Street, Manchester. "Motor Equipments for Main Rolling Mill Drives."

"THE INDUSTRIAL LEAGUE AND COUNCIL JOURNAL." Price 3d. Central office: 82, Victoria Street, London, S.W.1.

MESSRS. FURMSTON & LAWLOR, Birds Hill, Letchworth. "Service in Patternmaking."

Deaths.

MR. E. R. MERTON, who was a director of the late firm of H. R. Merton & Company, Limited, has died at the age of 71 years.

COLONEL W. D. REES, V.D., of Swansea, a well-known engineering expert, died at his residence in Ealing, London, W., on the 20th inst., after a long illness.

MR. S. W. FOXON, of Sheffield, has died at the age of 31 years. Mr. Foxon entered the service of Messrs. Arthur Balfour & Company, Dannemora Steel Works, sixteen years ago, and for some years travelled abroad extensively for the company.

MR. JOSEPH JONAS has died at his residence, Endcliffe House, Sheffield, in his 77th pear. He was a native of Bingen-on-the Rhine, in South Germany, and was born in 1845, going to Sheffield in 1867. In 1872 he was joined in partnership by the late Mr. Robert Colver, and in the course of years the businesses of Colver Brothers and of W. T. Beesley & Company were amalgamated with it. In 1892 the concern was converted into a private limited company, with a capital of £125,000. He was for many years a magistrate of the city, and was a Doctor of Engineering at the University. For three years he was a member of the Cutlers' Company, retiring in 1910.

XUM

IRON AND STEEL MARKETS.

Pig-iron.

The prospects of an early revival of activity in pig-iron production, though to some extent more encouraging, have so far failed in realising expectations, and markets everywhere remain in the same stagnant condition as previously reported. Fuel costs continue the dominant factor in the position, and though partially modified by concessions on the part of the coke-oven owners, the price still remains at too high a figure to permit of profitable furnace production. Yet another important obstacle to a full resumption of pig outputs is the slackness of demand for foundry products, buying for this industry having largely diminished of late. In South Staffordshire hardly any interest has been shown by the market in the renewal of supplies from some of the Derbyshire furnaces. Only very small lots have been bought at the prices quoted of £6 10s. for forge and £8 for No. 3 foundry. Belgian quotations are well below these figures, but there has been a substantial falling off in trade. In the Lancashire foundry iron market there is very little business passing. Orders for castings are not plentiful, and apparently the quantity of cheap foreign iron available is sufficient for the foundries at present. The nominal price of Derbyshire iron, local delivery, is about £8 7s. 6d. per ton, with Northamptonshire brands about the same, and Cleveland iron might be a little cheaper, but sellers there want the buyer to take a proportion of lower-grade pig-iron with every lot of No. 3. In the West of Scotland pig-iron prospects are improving. A few furnaces have re-started, and will be producing in a few days, and, with fuel cheapening, others will likely follow suit. Foundry pig-iron is particularly scarce, and stocks are taxed even to meet the small current demand. On Tees-side, although there is not as yet any real expansion of business in the Cleveland market, there are a few inquiries to hand, and a rather more hopeful view is taken. The prospect of cheaper fuel has revived hopes of more blast furnaces re-starting, and a definite announcement to this effect may be anticipated shortly. At the moment the number in blast in this district is reduced to 14 owing to the blowing out of a furnace at Cargo Fleet, but with cheaper coke available others may soon be started. At present it does not appear to be possible to buy Durham blast-furnace coke on short contracts at less than 30s. per ton at the ovens, but 25s. is spoken of as a likely figure, and ironmasters are quite hopeful of coke being available at that price in the near future. Then, perhaps, industry may witness a revival. Meanwhile, however, business is very slow, and foreign inquiries have almost entirely ceased. No differentiation is made in the price of forge and foundry qualities for home consumption or export, No. 3 Cleveland G.M.B. being quoted 135s.. No. 4 foundry 125s., No. 4 forge and mottled 117s. 6d., and white iron 115s. per ton. Stocks of foundry pig-iron in makers' yards are now either non-existent or very low. There is no No. 1, and the quantity of No. 3 is very small. There is a fair stock of No. 4 foundry, but the demand for this quality is almost negligible. Similarly, there is practically no market for No. 4 forge or for mottled and white irons, of which most makers have abundant supplies.

In the Cleveland market recently two more furnaces have been restarted on hematite, and the demand is showing some slight improvement, with a rather more active inquiry from abroad. Stocks are now extremely low, and prices are consequently firming up. For home consumption East Coast mixed numbers are strong at 160s., and makers are now quoting at least 150s. for export, as against 140s., and even less a week or so ago. In West Cumberland and North Lancashire hematite trade in the hematite market continues quiet, but signs are not lacking of a partial revival of active production. Already three furnaces have been restarted to meet actual needs of consumers, and with some prospect of a further reduction in raw material values and general working costs there seem good reasons to hope that the number of plants in operation will shortly be increased. Bessemer mixed numbers, meantime, have been reduced to £8 5s. per ton, delivered Sheffield, but the cut has not so far resulted in an increase of business.

Steel.

The situation in the home steel industries continues virtually unchanged, but if anything the volume of business passing is even less satisfactory than the conditions existing a month ago. Perhaps the only redeeming feature in an otherwise gloomy outlook is the recently announced placing of the Admiralty contracts for new capital ships, by which practically every branch of the steel trades will benefit, and very few firms will not enjoy a share. The demand for coal and coke will be stimulated, and the steel sections will feel the effects immediately of the placing of the specifications. Makers of files and various engineering tools, crucible and other special steel makers, engineering concerns, rolling mills and forges will all get their share, and it will mean many months' work for contractors and sub-contractors. Another favourable development in the position of the steel trade is the official announcement that the Ebbw Vale Steel, Iron and Coal Co. are restarting the whole of the iron and steel plant as soon as practicable. The works have been closed down for six months or more, and about 8,000 men have been idle. Engineering shops have already started, and mills will recommence this week, while furnaces will be set going in quick succession, with full work by October. It is also reported on reliable authority that one of the largest steelmakers in the West of Scotland has made arrangements for putting its plate and section mills on full work this week on account of home orders. Though the tonnage is not disclosed, it must be substantial to justify the step taken by so big an establishment. The developments thus foreshadowed are, of course, mainly attributable to the progressive decline in costs of production now proceeding, both fuel prices and labour charges being steadily reduced to levels which will permit of competitive activity on a more profitable basis than has hitherto been possible. The process of steel prices' deflation is now fairly general in all centres of production, and when something like normal values are practicable, given a revival of the world's demands, there should certainly follow a substantial expansion of business, if only on gradual lines. Reference to the German figures for 1913 show that the exports of iron and steel in that year amounted to 6,497,000 tons, and those of machinery and engines to 594,000 tons, making a total of 7,091,000 tons. As the imports of the two classes were 706,000 tons, the export surplus in favour of the country was 6,385,000 tons, or about one-third of the total production of steel in 1913, which amounted to 18,599,000 tons. Now when the steel productive capacity has been reduced to about 11,000,000 tons per annum, and the actual output is approximately 8,000,000 tons, it is found that the exports of iron and steel in 1920, as recorded by the official statement, amounted to only 1,750,000 tons, and those of machinery and engines to 397,000 tons, making a total of 2,147,000 tons. If the imports of 419,000 tons of iron and steel and 4,600 tons of machinery for 1920 be deducted the export surplus works out at 1,723,000 tons, which is a very favourable result in a year during which the reorganisation of the industry was still in progress.

Scrap.

In Yorkshire the scrap market is extremely depressed and is transacting only the minimum of business. Wrought-iron scrap is offered at about £3 10s. at works, with few buyers. Anything from £6 to £7 is mentioned for cast material, but only a small amount of business is reported. In South Wales the trade continues lifeless, and is very unsettled. Heavy steel scrap to the usual works specification is quiet at 60s. to 70s. Steel turnings are offered at 45s. to 55s., bundled steel scrap and shearings at 40s. to 50s., mixed wrought-iron and steel scrap for basic furnaces is quoted at 20s. to 70s., heavy cast-iron scrap in large pieces and furnace sizes at £4 to £5, and good machinery scrap at about £6.

Ore.

Business in the Tees-side foreign ore market remains dull and lifeless, with but poor prospects of revived animation until consumption at the blast furnaces is resumed. Stocks in hand at works are still on a heavy scale, and consumers are by no means anxious to increase future commitments until there is an improvement in the outlook for pig-iron. Operations in native iron ore have also been suspended for some time, but there is a prospect that another mine will be restarted in Cleveland in the course of a week or so. At the pit which is expected to be started shortly, it is understood, between four and five hundred men are ordinarily employed. Only at three mines, Marske, Great Ayton, and Eston, have operations been resumed, and only a small number of men engaged in the limestone quarries in South Durham have been able to return to work

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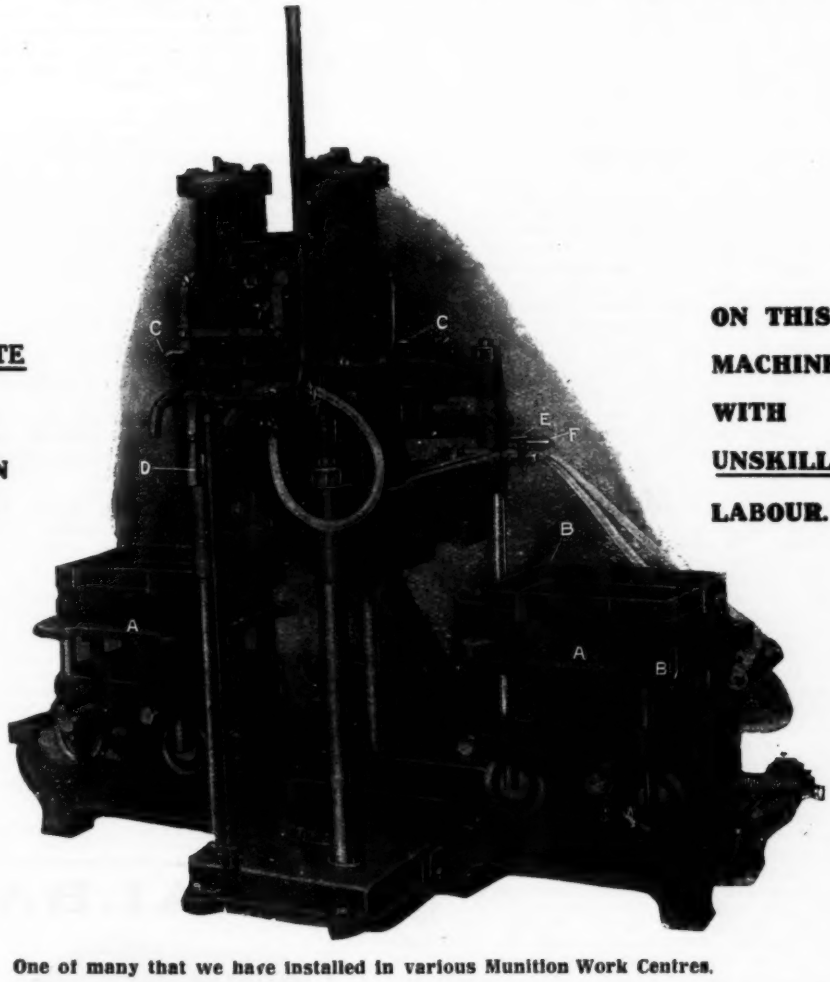

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Finished Iron.

In the principal markets for finished iron material present conditions are distinctly unfavourable to an expansion of trade either at home or abroad, the high values now quoted for products in all sections of the industry having a restraining influence on demand, which is still insufficient to keep works employed on anything like full time. In the existing conditions, finished iron makers in South Staffordshire are naturally reluctant to resume manufacturing operations while so much uncertainty as to the future remains, and although producers of best bars are receiving some orders, mostly from engineering firms, there is not a great amount of fresh business being placed at present. These orders are mainly, if not entirely, for near requirements, there being little inducement at the moment to book on forward account. The improved labour outlook in the shipyards is expected to be reflected in some Midland industries. Unmarked bar iron and the different manufactures of which it is the base, are almost entirely dominated by foreign competition. It is reported that supplies have been offered in some cases at £1 below the Association rate of £16, but with Continental shippers willing to make delivery at £9 10s. to £10, it is obvious British mills have not much chance. When all the new business is added together, it does not amount to very much for the foreigner or the home producer, inasmuch as consumers are working on stocks as far as possible. There has not yet been any change announced in the Lancashire Association prices for finished iron, but it is generally believed that some reduction is now under consideration. In any case, buyers do not come forward at the present official rates.

Tinplates.

Business in the tinplate market remains in an unsatisfactory condition, and notwithstanding a more general resumption of work at the mills, the ouput continues only about one-fourth of the normal average. The industry, however, promises to undergo some improvement within the next month or so, provided the terms quoted are made sufficiently attractive to induce more confidence. A majority of the merchants anticipate that the basis price for new plates will settle down in the region of 20s. per box, but makers' costs will hardly be brought down sufficiently yet awhile to permit it to go as far as this. Shipments to the Far East have been more active, but current output is quite large enough to meet the spasmodic demand, especially for the home trade.

Metals.

Copper.—The easier tone which had been apparent in the standard copper market for some time was succeeded towards the week-end by a stronger tendency, influenced probably by the interest attracted by the lower values ruling, and subsequently prices recovered, so that quotations on Friday reflected a slight advance. In the same period however, it should be noted that electrolytic had eased off about 15s., due to an improvement in the American exchange. The demand on home consumers' account is, however, still on a restricted scale, the inquiries to hand being limited in quantities to meet immediate needs, and the total sales continue unimportant in volume. The week's markets opened with a firm tone, there being a fair demand for three months' metal, and, influenced by some good buying, values for forward metal advanced sharply, and both cash and three months closed higher. Refined descriptions continue a quiet market, with electrolytic quoted £70 10s. to £72 10s., and wire bars £71 to £72 10s. Closing prices :—Cash, Wednesday, £66 15s.; Thursday, £66 5s.; Friday, £67 10s.; Monday, £67 17s. 6d.; Tuesday, £67 12s. 6d. Three Months.—Wednesday, £67 5s.; Thursday, £66 17s. 6d.; Friday, £68 2s. 6d.; Monday, £68 10s.; Tuesday, £68 5s.

Tin.—The market for this metal has for some time past experienced considerable liquidation, with prices showing a consistent downward tendency. During the past week values eased off still further until on Thursday the closing quotation for cash stood as low as £149. This figure, however, attracted buyers, and with a good demand for standard metal prices recovered sharply, showing an appreciable advance at the end of the week. Demand on the part of consumers remains, however, limited in volume, and notwithstanding increasing activity in the South Wales tinplate trade market business continues restricted in volume. This week's markets opened with more favourable Eastern advices, and under some good covering of September and three months, values reflected a hardening tendency, closing firm with both cash and forward dates higher. September was done at £152 to £153, early October £153, middle November £154 10s. Straits tin was quoted £154, Australian £154, Banca £155, Chinese £148 15s., English ingots £152, refined £154 to £155. (American prices, spot 26.00, £157 16s.) Closing prices :—Cash : Wednesday, £150; Thursday, £149; Friday, £152; Monday, £153 5s.; Tuesday, £156 10s. Three Months : Wednesday, £151 10s.; Thursday, £150 15s.; Friday, £154; Monday, £155 5s.; Tuesday, £155.

Spelter.—Buying movements in the spelter market are chiefly restricted to consumers' bare requirements, and although there is some suggested revival in the galvanised sheet trade, it has not so far influenced a brisker condition of business, as had been anticipated by dealers in the metal. A fair business was, however, passing in this week's markets, with recent values well upheld. September sold at £24 15s. October sellers, £25 2s. 6d. December metal at £25 10s. Closing prices :—Wednesday, £24 12s. 6d.; Thursday, £25; Friday, £25 5s.; Monday, £25; Tuesday, £24 17s. 6d.

Lead.—The market for this metal remains steady throughout, and without any distinct improvement in the volume of business passing, consumptive demands continuing on a fair average, but with little disposition to exceed immediate requirements. There were September sellers at £23 10s., with buyers at £23 7s. 6d. October was quoted £23 2s. 6d., November sellers at £22 17s. 6d., and December sold at £22 12s. 6d. for soft foreign pig. English has remained firm and unchanged at £24 5s.

MACHINERY advts., see also page 20.

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Two Roots Blowers, by Samuelson & Company, Limited, Banbury, sizes M.P., No. 4,848 and No. 2,795.
One 10-ton Weighbridge, by A. & W. Smith, Glasgow.
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